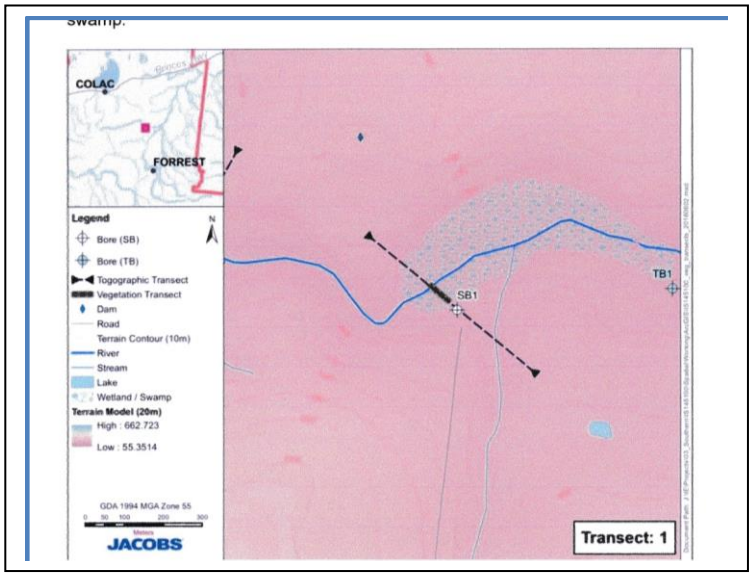
The Roger Blake Report & Some Follow Up to Questions raised in Otway Water Book 31

.



.

OTWAY WATER BOOK 38

Malcolm Gardiner

Disclaimer

This book may be of assistance to you, but there is no guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaim all liability from error, loss or other consequence that may arise from relying on any information in this book.

This book has been prepared, and supporting documents used, with diligence. Statements within this publication that originate from groups or individuals have not been evidentially tested. No liability is accepted from any action resulting from an interpretation of this book or any part of it. The data in this book is arrived at from information sourced and available in the public domain at the time. The passage of time, manifestation of latent conditions or impacts of future events may necessitate further examination and subsequent data analysis , and re-evaluation of the data, findings, observations and conclusions expressed in this book. This book has been prepared in accordance with care and thoroughness. No warranty or guarantee, whether expressed or implied, is made of the data, observations and findings expressed in this book. This book should be read in full. I accept no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this book by any third party. However, I do sincerely hope this book encourages you to enquire about and or further evaluate the material presented and diligently follow up on any aspect of Otway Ranges water resource management that may have been aroused in your mind but not answered.

February 2018

INTRODUCTION.

This Book is made up of two sections. The first is a copy of a report Roger Blake first tabled at a meeting between himself, Jim Lidgerwood and myself with Tracey Slatter (CEO) and Jo Plummer (Chair) of Barwon water, May 2017. This meeting came about following discussions between a group of concerned citizens regarding water resource management in the Otway Ranges and Richard Riordan (MP). There are a few points in Roger's report needing clarification which I have attempted, but in essence this report is an excellent summation of mistakes made in the past regarding the allocation of groundwater extraction rates at the Barwon Downs Borefield. Roger's report has been circulated to the members of the Barwon Water Groundwater Community Reference Group that is assisting and looking into the renewal of the groundwater extraction licence process due in 2019.

The second section covers the lead up and explanation given to some of the mistakes found in two of Jacobs reports that had previously been presented to this Reference Group. The reason for inclusion with the above section will become obvious as these mistakes were pointed out at the 4 May 2017 meeting as mentioned above, and assurances made that they would be answered.

"*The new monitoring program will increase understanding of the Barwon Downs groundwater system in its normal state.*"
(SKM 2015)

"***No evidence was found that declining groundwater levels caused by groundwater extraction at Barwon Downs had a negative impact on vegetation health in the catchment.***"
(Jacobs 2016)

"***...water table drawdown occurs during pumping, but no long-term environmental impacts have been linked to borefield operation.***"
(Barwon Water, February 2012:Water Supply Demand Strategy 2012-2062, Draft.)

SECTION ONE (Pages 4 -37).

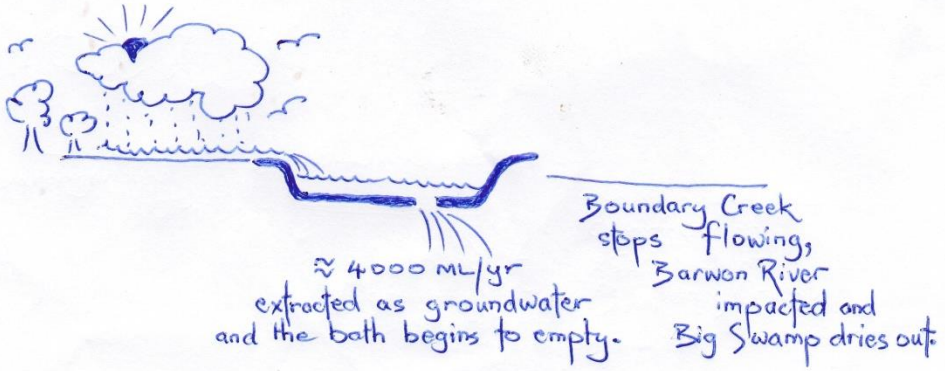
The 4 of May meeting with Barwon Water had to be before the 7th of May when both Roger and I were leaving the country for some considerable time, and because of this extremely tight time line there was little chance for Roger and I to thoroughly proof this report. Some dates need to be updated and I have done this throughout Roger's report as presented below. Additional comments have been added and are solely my ramblings.

Winchelsea Landcare Group Submission to Barwon Water on the Gerangamete Borefield and environmental state of the Barwon River catchment, Southwest Victoria.

Presentation to Tracey Slatter, Managing Director and Jo Plummer, Chair of Barwon Water

Roger Blake, Malcolm Gardiner and Jim Lidgerwood
4 May 2017

Using Roger's explanat^n of how it works, makes little difference to whether the Big Swamp is directly connected vertically in the LTAs or not. If the bath tub is full then the BSWetland will be overflowing and completely saturated; BCrk will flow & the BRiver will recieve an overflow of at least 2300 ML.



CONTENTS

S

Executive Summary

1. Environmental damage in the Boundary Creek, "the Big Swamp" and the Barwon River

Pumping from the Gerangamete Borefield lowered the aquifer pressure and therefore the water table below the Boundary Creek and surrounding intake area. This diverted surface water from the Boundary Creek and "the Big Swamp" into the aquifer below. The Boundary Creek became a "losing stream" and remained so as long as the water table remained below the surface level of the creek. (Remains)

The complete drying out and degradation of Boundary Creek (a tributary of the Barwon River) that included the subsequent catching fire of "the Big Swamp" in 1997 and again in the same summer of 1998 and again in 2010 was caused by over pumping from the Gerangamete Borefield.

Very high to extreme pH values in Boundary Creek, first observed in June, 1990 resulted from acidification caused by drying out of "the Big Swamp". Extreme acid water (pH values from 3.0 to 4.0 or 1000 to 10,000 times normal) flowed into the Barwon River culminating in a massive fish kill in the Barwon River in June/July 2016.

2. The oxidation of pyrite in a Peat Swamp

When a peat swamp commences to dry out, for whatever reason, the chemistry of the peat dramatically changes. Once the peat commences to dry out oxygen is introduced into the peat. The pyrite (fools gold) in the peat, previously stable, commences to oxidize according to the following reaction.

FeS_2 O_2 H_2O $FeSO_4$ H_2SO_4

Iron Sulphide + Oxygen + Water = Iron Sulphate + Sulphuric Acid

Sulphuric acid is a strong acid and is the electrolyte used in common lead-acid car batteries. At pH values less than 5.0 the sulphuric acid in solution is a toxic component of water and lethal to fish and other aquatic species In the streams it used to be 6-7 pH w occassional levels a little lower.

3. The cause of the extreme acid events in Boundary Creek

It can be concluded without any doubt that the cause of the very high acid content of Boundary Creek was the high levels of pumping in the Gerangamete Borefield. The high pumping levels from the aquifer caused the water level in the aquifer to drop permanently below "the Big Swamp" thus causing the peat swamp to dry out.

It can be concluded that drought was not a cause because the first extreme pH values in Boundary Creek appeared in June 1990, 15 years before the "Millennial Drought" commenced in 2005.

S

Similarly it can also be concluded that fire was not the cause of the extreme pH levels in the Boundary Creek. The peat in "the Big Swamp" caught fire in the very top section of the Big Swamp in 1997 over seven years after the first extreme pH's were observed in June 1990. The lower reaches of the swamp caught fire in later years as the pumping from the Borefield progressed and the swamp further dried out.

4. Estimate of the long-term average recharge to the aquifer

In 1996 the DNRE published a report on the Barwon Downs aquifer and the Gerangamete Borefield. This is the current definitive published report of the aquifer and Borefield. The sustainable e DNRE estimated the total annual recharge on the Barongarook High by inputting a value of 20 sq. km for the area, an average annual rainfall of 900 mm and 8.0 percent of rainfall being infiltrated as recharge giving an annual recharge of 1,440 ML. The DNRE report rounded this value up to 1,500 ML per year.

Mining

This estimate of 1,500 ML per year of recharge is currently the most definitive published estimate of the recharge to the Early Tertiary aquifer on the Barongarook High area that is publically available. This is the sustainable yield from the aquifer and any more results in "mining" of the groundwater resource.

5. The Southern Rural Water (SRW) revised Borefield Licence

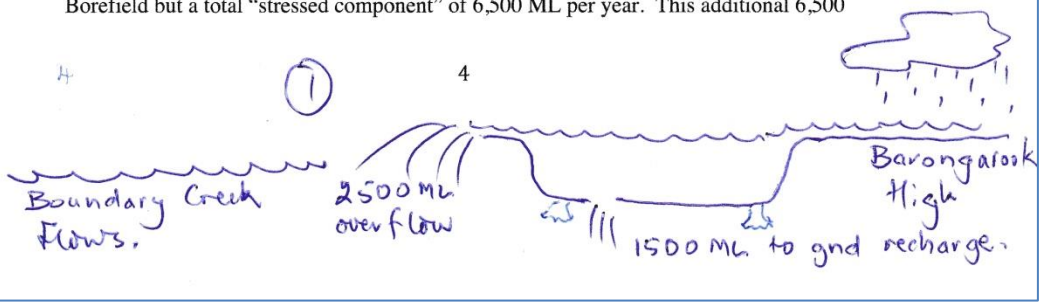
None stress level.

The current Borefield Licence issued by SRW in 2004 to Barwon Water is for 20,000 ML per year (or 80,000 ML in 10 years or 400,000 ML in 100 years).

The Licence includes a natural recharge component of 1,500 ML per year. This is the sustainable extraction calculated by the DNRE that can be achieved without "stressing" the intake area

The DNRE report included a "stressed component" of recharge. The "stressed component" from the aquifer is estimated by the DNRE to be 2,500 ML per year (i.e. the difference between their recommended 4,000 ML per year and the sustainable recharge of 1,500 ML per year). This additional component of groundwater can be extracted from the aquifer by over-pumping of the Borefield, as concluded by the DNRE. *"This enhanced recharge is largely derived from increased surface water infiltration and interception of groundwater inflows to Boundary Creek and spring systems on the Barongarook High"*. And further *"will result in the watertable being lowered on the Barongarook High and will have an impact on the Boundary Creek and associated spring systems because of the high degree of hydraulic connection that exists between the aquifer system in the graben and aquifer outcrop on the Barongarook High"*.

The current SRW licence effectively made a decision to licence not just the further "stressed component" of 2,500 ML per year (calculated above) to the Barwon Water Borefield but a total "stressed component" of 6,500 ML per year. This additional 6,500



8000 per yr for 10 = 80,000 limit.

ML per year is the difference between the sustainable component of 1,500 ML per year estimated by the DNRE and the effective 8,000 ML per year of the current licence. This 6,500 ML per year is taken from the surface water runoff from the Barongarook High, which normally flows to the Barwon River via the Boundary Creek. or taps into the reserves in the LTAs

SRW fully aware

This decision by SRW to allocate the extra 6,500 ML per year was made in the full knowledge of the environmental effects detailed in the DNRE, 1996 report.

This licence to Barwon Water effectively excluded any landowners or communities in the Barwon River catchment from accessing the Early Tertiary aquifer on their properties because it allocated the full sustainable recharge rate to Barwon Water. This negated the groundwater entitlements of Barwon River catchment landowners

BW given full control of gnd.

Locals not really considered.

The SRW Borefield Licence effectively put the interests of the Geelong clients of Barwon Water ahead of the interests and water entitlements of Barwon River catchment landowners. Other receptors.

The current Borefield licence is effectively 8,000 ML per year over 10 years (or 20,000 ML per year in any one year). There is absolutely no difference between issuing a Licence for the Borefield of 1,500 ML per year and issuing a surface water licence to extract 6,500 ML per year from the Barongarook High and Boundary Creek. SRW could have achieved the same result of 8,000 ML per year by issuing a licence to pump 1,500 ML per year from the Borefield and by issuing a licence to put a dam across the Boundary Creek above the confluence with the Barwon River. A volume of 6,500 ML per year of surface water in the dam could have been piped (or pumped) from the dam to the Upper Barwon – Wurdee Bolac channel

See Otway Water BK "Sick of Hearing That"

If SRW had made a decision to dam the Boundary Creek and divert 6,500 ML per year to Barwon Water there would have been a requirement for a full Environmental Impact Statement (EIS). This would have required input from other Government agencies regarding its impacts and allowed for general public input, including affected landowners in the Barwon River catchment, into the decision. The SRW Licence therefore effectively removed the scrutiny required for further surface water allocations to Barwon Water.

Enough "things" indicating & ignored indicating caution.

By allowing the additional 6,500 ML per year to the Gerangamete Borefield Licence, SRW effectively removed a long-term sustainable flow of 6,500 ML per year of the Boundary Creek into the Barwon River.

The SRW decision to licence the additional 6,500 ML per year effectively bypassed the need for any Government Department, CCMA or public review of the sustainable surface flows contributed by the Boundary Creek to the Barwon River.

Over the 27-year period from 1983 to 2010 the total volume extracted of 122,358 ML was 3.03 times the total sustainable recharge of 40,500 ML (i.e. 27 times 1,500 ML) over the Barongarook High intake area over the 27-year period. It can be concluded that it is

of no surprise that the Boundary Creek and Barwon River have responded in the way they have to this massive over exploitation of the groundwater resource. The aquifer is not being developed in a sustainable manner but is being "mined".

Mined.

The groundwater consultants to Barwon Water (SKM now Jacobs) have long maintained that the sustainable yield from the Barwon Downs Borefield is vastly greater than the DNRE estimate (up to 20,000 ML per year compared to 1,500 Ml per year estimated by the DNRE report, or by a factor of over seven times) but Barwon Water have never made available the basis on which their the consultants calculations are based.

There should be an independent technical audit of the consultant's estimates undertaken in order to determine the reason for the extraordinary discrepancy between the consultant's estimates of sustainable yield compared to those of the DNRE.

The commissioning of the independent audit should be by the relevant authorities, principally SRW with input from the CCMA, the authorities responsible for the determination of the Borefield licence and for the maintenance of environmental flows in the Barwon River, with input from the Barwon Catchment stakeholders.

AND any other impacted stakeholders.

6. Conclusions and Recommendations

No blame (1)

A final conclusion is that the environmental degradation of the Boundary Creek and Barwon River is now obvious and action must be taken. It is not necessary to apportion blame for the current situation prior to undertaking action.

Just get it right.

Don't delay (2)

It is not appropriate to delay a decision by appointing new committees or undertaking further environmental studies, or technical audits which would have the direct effect of delaying addressing the problem and pushing remedial action into the "too hard basket".

Fix it (3)

A program of remedial works should be undertaken on Boundary Creek to address the presence of the very high to extreme acid waters. Environmental flows should be restored to the Barwon River, particularly in the vulnerable summer and autumn periods.

Licence (4) down graded to 1500 ML year.

The Borefield licence expires in 2019 and should be revised downwards to the long term 1,500 ML per year, which is the sustainable volume of intake on the Barongarook High intake area, calculated by the definitive DNRE, 1996 report.

9. Conclusions and Recommendations

It can be definitively concluded that the environmental degradation of the Boundary Creek and Barwon River is now obvious and action must be taken. It is not necessary to apportion blame for the current situation prior to undertaking action.

Repeat of pt 6.

It is not appropriate to delay a decision to take action by appointing new committees or undertaking further environmental studies, or undertaking new technical audits. These actions would only have the effect of delaying addressing the problem and pushing remedial action further into the future or even into the "too hard basket".

A program of remedial works should be undertaken on Boundary Creek to address the presence of the very high to extreme acid waters. Environmental flows should be restored to the Barwon River, particularly in the vulnerable summer and autumn periods.

The Borefield licence should be revised downwards to a long-term average of 1500 ML per year. Some allowance in this licence should be made for Barwon Catchment landowners and communities.

See Pages 29-37.

List of figures

Should have/Could be added to this list

Introduction

This report has been prepared to support a presentation to Tracey Slatter, Managing Director, and Jo Plummer, Chair of Barwon Water, regarding local landowners and Landcare members in the Barwon River catchment concerns about the operation of the Gerangamete Borefield and the consequent environmental damage to the Boundary Creek and Barwon River.

?? Loves Crk & Gellibrand River.

This presentation summarizes the current state of knowledge of the geology, hydrogeology and history of Borefield extractions from the Barwon Downs Early Tertiary aquifer. This report is based to a large part on a report by the Victorian Department of Natural Resources titled "Groundwater Development Options and Environmental Impacts – Barwon Downs Graben South West Victoria". (DNRE, 1996) The reports authors were S. Witebsky, C. Jayatilaka and A. Shugg and edited by C. R. Lawrence, R. Lakey and A. Shugg.

↑ Charles (Melb Uni.) retired.

Shugg & a Uni Student "critted" Witebsky et.al.

The report is the most definitive public document available on the Geology, Hydrogeology and Environmental impacts of the Gerangamete Borefield operated by Barwon Water. The report also published the results of a comprehensive and thoroughly calibrated groundwater mathematical model of the Barwon Downs Graben.

The complete drying out and degradation of Boundary Creek (a tributary of the Barwon River) that included the subsequent catching fire of "the Big Swamp" in 2008 is of great concern to landowners in the area, in particular landowners along the Barwon River. The degradation of Boundary Creek has been thoroughly documented by local Kawarren landowner, Malcolm Gardiner. Very high to extreme pH values in Boundary Creek, first observed in June, 1990 culminated in a massive fish kill in the Barwon River in June 2016.

2010 ← 1997

Fish Kill

3 things the authorities HAVEn't done

It is of great concern to Landowners and Landcare members that no action has been taken by relevant authorities to identify the cause, or remediate the effect of, the extreme acid values in Boundary Creek that have led to the massive fish kills in the Barwon River. Of further concern is the fact that there has been a general degradation of the Barwon River over the last 30 years or so and Landowners believe that this is caused by overdevelopment of both the groundwater and surface water resources in the Barwon River catchment.

other concerns

Landowners are also concerned that there is no defined policy by Management authorities with respect to identifying, or quantifying and implementing, the environmental flows necessary to sustain the health of the Barwon River and its catchment. Many landowners from Forrest to Geelong are dependent upon the health of the Barwon River.

Geology and Hydrogeology

Figure 1 (from figure 21 DNRE report) shows the important geological units outcropping in the Barwon Downs Graben and Barongarook High. Superimposed on the geological map are the water table contours (Potentiometric Surface) in the Early Tertiary aquifer developed in the Gerangamete Borefield.

The three geological units of importance on figures 1, 2 and 3 are in order, The Early Cretaceous Otway Group coloured in green, the Early Tertiary aged (Paleocene to Eocene), Dilwyn and Pebble Point Formations coloured in Brown and the Late Eocene to Middle Miocene aged Narrawaturk Marl and Gellibrand marl coloured in yellow.

From a hydrogeological viewpoint the Otway Group represents bedrock and therefor does not contribute to the groundwater system. The Dilwyn and pebble Point Formations contain the major aquifer sands and are the aquifers developed in the Gerangamete Borefield. The Narrawaturk Marl and Gellibrand Marl are predominantly calcareous clays to silty clays and are the confining beds to the aquifer system. The Narrawaturk Marl can be up to 40 percent organic material with two to five percent pyrite as an accessory mineral where it is present on the Barongarook High overlying the aquifer.

In areas where the Narrawaturk and Gellibrand Marl outcrop (over most of the Barwon Downs graben), the aquifer is confined and in places artesian. On the Barongarook High the aquifer can be confined by clays inter-bedded with the sands, or it is unconfined in areas where the sands outcrop.

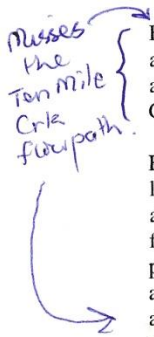


Figure 2 (after figure 21 DNRE report) shows the geology and potentiometric contours and subsurface flow directions of the groundwater in the entire Barwon Downs Graben area in February 1987 prior to any substantial groundwater extraction from the Gerangamete Borefield.

Figure 1 shows the maximum height of the potentiometric contours is 230 m above sea level in the western part of the outcrop on the Barongarook High. This drops to 160 m above sea level along the eastern area of outcrop along the Boundary creek. The original flow direction (prior to major pumping) is shown in red arrows (at right angles to the potentiometric contours) on figure 1 and 2. Groundwater flowed to the northeast, east and southeast into the Barwon Downs graben from the Barongarook High. Groundwater also flowed southwest towards the Loves Creek and the Gellibrand River area southwest of the Barongarook High. Loves Creek rise on the Barongarook High and flows southwest to become a tributary of the Gellibrand River, rather than the Barwon River.

The hydrology of the Boundary Creek

Prior to 1987 the Boundary Creek was a gaining stream fed year round by springs and base flow from the surrounding Early Tertiary aquifer outcrop. On figure 1 (taken from figure 21 of DNRE report) the outcrop of the Early Tertiary aquifer outcrop is shown. Between points A and B the creek has cut a valley through the aquifer sands into the

Otway Group bedrock. Over this section the creek is always a gaining stream and maintains base flow from springs and resulting from outflow from the aquifer outcrop.

Between points B and C the creek cuts through the Tertiary aquifer sands. A permanent peat swamp, "The Big Swamp" existed between points B and C upstream from the bridge over the creek on the Colac-Forrest Road. Over this section the creek was normally a gaining stream and springs and outflow from the Tertiary aquifer maintained the water level in the permanent peat swamp.

Big Swamp was always saturated

Below point C the creek flows over the Gellibrand Marl confining beds and does not receive base flow from the Tertiary aquifer. Just below point C the creek joins the Barwon River where it was a major contributor to environmental flows in the river, particularly in the dry summer and autumn periods when it flowed continuously because of the base flow contributed from the Tertiary aquifer.

B/Crk always flowed

Estimate of the long-term average recharge to the aquifer

Figure 1 shows the area of aquifer outcrop on the Barongarook High. The area was geologically mapped by the Geological Survey of Victoria and the surface mapping was supported by subsurface data from over 30 bores and observation bores drilled as part of the Victorian Government investigation. This map is currently the most definitive geological map of the Barongarook High area.

The area of aquifer outcrop was estimated to be 20 square kilometers in the DNRE report (Page 57).

Intake area

The DNRE developed a mathematical model of the Barwon Downs graben using the MODFLOW computer program developed by the United Sates Geological Survey (USGS). The model was calibrated to the original groundwater potentiometric contours in the Barwon Downs graben and the Barongarook High. The percentage of rainfall (X %) that is diverted to recharge was estimated from the model. On page 83 of the report a value of 8.0 % for the recharge was calculated as flows *"In the initial model runs a range of X values (5% - 15%) was considered, and after comparing the overall match between the predicted heads and the observed water table and potentiometric surface 8% was chosen as a reasonable value"*. Thus 8.0 percent of the annual rainfall over the area of outcrop of the Early Tertiary aquifer over the Barongarook High is considered to intake into the aquifer. The balance of the annual rainfall (92 percent) is accounted for by evaporation, transpiration by vegetation and direct runoff mostly to the Boundary Creek to the east and to the Loves Creek to the southwest.

Recharge. Jacobs says 10% (2016) But could have different a) area b) rainfall values. AND because of depleted aquifers (LTAs) the intake would increase.

On page 56 of the report an average value of annual rainfall of 900 mm was used in the recharge calculation as follows *"The Barwon Downs area lies in a high rainfall part of Victoria with an average winter dominated annual rainfall over 900 mm".*

The DNRE report estimated the total sustainable recharge to the Early Tertiary aquifer in Megalitres on the Barongarook High as follows.

Area of intake (square metres)* Average Rainfall (in metres) * Percent recharge

Inputting the appropriate values (20 sq. km, 900 mm and 8.0 %) gives an annual recharge of 1440 ML. The DNRE report rounded this value up to 1500 ML per year.

This estimate of recharge is currently the most definitive published estimate of the total recharge to the Early Tertiary aquifer on the Barongarook High area that is available.

Jacobs will argue this.

Borefield pumping 1987 to 1990

These extracts 1982-83 has The first of various figs. 2000 ML 3000 ? 8000

There have been four major pumping periods from the Gerangamete Borefield since it was first established in the early 1980's. Figure 3 shows the pumping events in Megalitres per year together with the average yearly rainfall at the Cape Otway Lighthouse in millimeters per year over the period 1973 to 2015. The four-year pumping period from 1987 to 1990 was documented and analyzed in the DNRE report. Monitoring of observation bores in the Barwon Downs graben and on the Barongarook High was undertaken over the entire pumping period and hydrographs of these monitoring records were used to calibrate the mathematical model of the aquifer.

Figure 4 (after figure 24 DNRE report) shows the potentiometric surface in the Early Tertiary aquifer on 15 February 1990 following a four-year pumping period with a total extraction of 22,888 Megalitres (ML) from 1987 to 1990. An enlarged version of figure 4 is shown on figure 5 and shows the potentiometric surface after pumping had ceased. Also shown on figure 5 is the location of three Observation bores (Gerangamete 14, Yeo 21 and Yeo 19) that were monitored during the four-year pumping period.

Gerangamete 14 is located immediately adjacent to the Gerangamete Borefield and figure 6 shows the maximum drawdown of about 60 m had been achieved by January 1990. Yeo 21 is located adjacent to the Boundary Creek on the Colac-Forrest road and is located on Gellibrand Marl outcrop where the aquifer is in a confined location but closer to the Barongarook High. Figure 7 shows the maximum drawdown in the aquifer was approximately 30 m in Yeo 21 at the end of pumping in January 1990.

Yeo 19 is located adjacent to the Boundary Creek and "the Big Swamp" and is within the area of aquifer outcrop on the Barongarook High intake area. Figure 8 shows Yeo 19 had a maximum drawdown of approximately 25 m at the end of four years of pumping in January 1990.

To put this in perspective, after four years of pumping the water table had dropped 25 meters below the level of the original groundwater surface that outcropped along the Boundary Creek and "the Big Swamp". The Boundary Creek, which was always a "gaining stream" over this section (see above), would have become a "losing stream" due to the drop in the groundwater table. Water, which normally flowed from the aquifer to the stream, would be reversed and flow from the stream and "the Big Swamp" into the aquifer.

By 1990 Big Swamp drying out. Flows ↑ reversed ↓.

aquifer.

Long term monitoring of pH values in Boundary Creek and Loves Creek

"Obtained" from vic water data warehouse (Vic Government data AND UBLN data 2.8 pH. extra to what Roger has used.

Water quality data for the Boundary Creek and Loves Creek has been obtained by Kawarren landowner, Malcolm Gardiner both of which flow off the Barongarook High for the period 1983 to 2008. Monthly pH values were taken in both creeks over the period. The pH values for the Loves Creek oscillate between a pH of about 6.0 to a pH of about 8.0. This is exactly what would be expected so the Loves Creek values can be considered as a control data set for pH values in the Barongarook High area.

The pH values in the Boundary Creek show a completely different history for the same period. Figure 9 is a plot of the Boundary Creek pH, the Loves Creek pH, the yearly rainfall for Cape Otway and the history of pumping from the Gerangamete Borefield over the period 1983 to 2008. Years of above average rainfall are shown coloured in green on the rainfall chart.

On the left hand side of the chart the pH scale is shown from zero to 14.0 as is customary for pH. In reality pH is actually a logarithmic scale and the logarithmic values are also shown on the left hand side of the chart. For example, if a value of 1.0 is assigned to pH 7.0 then a pH of 6.0 is 10 times the acidity of pH 7.0, a pH 5.0 is 100 times, a pH 4.0 is 1,000 times and a pH 3.0 is 10,000 times as acid as a water with a pH of 7.0. On the right hand side of the chart is a relative measure of acidity for natural waters that would be encountered in streams such as Loves Creek and Boundary Creek.

In light of comments attributed to unnamed experts in Government Authorities that the pH values in Boundary Creek are "normal", the following is a scale of values that the present writer considers appropriate for waters in creeks such as Loves Creek and Boundary Creek in cool temperate Southwest Victoria.

A normal pH is defined as between pH 8.0 and pH 6.0. For example for the period from 1991 to 2008, pH values in Loves Creek oscillate between pH 6.0 and 8.0 (i.e. oscillate about the neutral pH value of 7.0). This is exactly what would be expected for a creek of this type flowing over the geological units shown on figure 1 and for this cool climate rainfall and temperature regime.

A high pH is defined from 6.0 to 5.0, a very high pH is defined from pH 5.0 to 4.0 and an extreme pH is defined from 4.0 to 3.0.

In the Boundary Creek extreme values of pH (i.e. pH values between 3.0 and 4.0) were first encountered in June 1990. For reference, this is between 1,000 and 10,000 times the "normal" pH values encountered in Loves Creek over the same period of time.

A detailed discussion of the trend in the pH of Boundary Creek is given below in the section - Analysis and cause of extreme pH values in Boundary Creek 1990 to 2008.

The Formation of acid sulphate water in Boundary Creek

A committee of Government authorities has been formed to assess the existence of acid sulphate waters in Boundary Creek. There appears to be either a considerable misunderstanding of, or alternatively a reluctance to accept, the causes of the high acid sulphate water flowing out of the Boundary Creek and into the Barwon River by the relevant authorities. Newspaper reports attributed to the State authorities (see above) state that the acid sulphate water is a "normal occurrence". However the very high to extreme acid contents of between pH 3.3 and pH 5.0 that have been recorded in the Boundary Creek are most definitely not normal for streams of this kind.

The process of the natural formation of acid sulphate water is a well-understood process and has been well documented by the United States Geological Survey (USGS 1962). The detailed chemical reactions involved in the formation of acid sulphate waters and the stability field diagram for Eh (oxygen Potential) versus pH (acid content) for the Ferrous-Ferric system from the USGS, Water-Supply paper are included here in Appendix A.

Acid sulphate water is also a very common by-product of mine waste dumps and slime dams resulting from mining activity. The oxidation of metal sulphides, in particular pyrite (or fools gold), in the waste dumps and slime dams to produce acid sulphate water is a well-understood and documented process. (cotf.edu, 2004). The oxidation of metal sulphides in mine waste dumps produces "extreme" pH values by a process of chemical reactions similar to that produced by the oxidation of pyrite in a peat swamp resulting from the drying out of the peat swamp. The chemical equations responsible for the production of acid sulphate water are reproduced here in Appendix A

The deposition of pyrite in a Peat Swamp

Best explanation I have read how peat & Acid etc. happens.

In a peat swamp such as "the Big Swamp", the high organic content in the water consumes all the free oxygen in the water. Under these conditions the water has a low Eh (oxygen content) and is in the anaerobic state (oxygen free). Iron, normally in the oxidized state (ferric) is converted to the reduced state (ferrous) by the low oxygen environment. Sulphur in solution, normally in the oxidized state (sulphate ions) is converted to the reduced state (sulphide ions) by the low oxygen environment.

The ferrous cations (positive charge) combine with the sulphide anions (negative charge) to form pyrite (fools gold), which is deposited in the peat. The pyrite is present in small veins or cracks in the peat or it is distributed as individual crystals distributed throughout the peat. As long as the peat remains water saturated the pyrite continues to deposit in the peat as the peat deposit builds up due to the accumulation of vegetation in the swamp.

Easy to understand.

The oxidation of pyrite in a Peat Swamp

However, should conditions cause the swamp to dry out, for whatever reason, the chemistry of the peat dramatically changes. Once the peat commences to dry out oxygen is introduced into the peat. The pyrite, previously stable, now commences to oxidize according to the following reaction.

(Fools Gold) FeS_2 $FeSO_4$ H_2SO_4

Iron Sulphide + Oxygen + Water = Iron Sulphate + Sulphuric Acid

(Pyrite)

Sulphuric acid is a strong acid and is the electrolyte used in common lead-acid car batteries. At pH values less than 5.0 the sulphuric acid is a toxic component of water and lethal to fish and other aquatic species. It is also toxic for animals, both native and farm livestock if consumed. The detailed chemical reactions that give rise to the Sulphuric Acid and ultimately oxidize pyrite to the mineral limonite (iron hydroxide, commonly known as yellow or red ochre) and the stability field diagram for the aqueous ferric-ferrous systems are given in Appendix A.

Once "the Big Swamp" had commenced drying out, each successive rainfall event soaked through the peat, oxidizing pyrite and leaching Sulphuric acid and Iron Sulphate into the newly lowered water table below the peat. This in turn caused the pH to drop as the hydrogen ion from the dissociation of the Sulphuric acid accumulated in the groundwater.

Finally, a high rainfall event (for example in winter following low flows in Summer and Autumn), can temporarily raise the water table and flush the extremely high acid groundwater (pH 3.0 to 4.0) out of the aquifer into the Boundary creek and finally into the Barwon River.

Are the LTAs being polluted AS WELL???

The causes of drying of a Peat Swamp

The drying of a peat swamp can be achieved by man-made processes or by natural processes. With man made processes, swamps can be deliberately drained by digging drains, diverting surface water away from the swamp or, as happened in the case of "the Big Swamp" by lowering the water table under the swamp by excessive pumping from the aquifer below.

In the case of "the Big Swamp", pumping from the Gerangamete Borefield lowered the aquifer pressure and therefore the water table below the Boundary Creek and surrounding intake area. This diverted surface water from the Boundary Creek and "the Big Swamp" into the aquifer below.

As discussed in the hydrology of the Boundary Creek above, between points B and C the Boundary Creek and "the Big Swamp" was normally a gaining stream. However with sustained pumping from the Borefield the Boundary Creek became a "losing stream", and remained so, as long as the water table remained below the surface level of the creek.

Pumping & Big Swamp dry.

Analysis and cause of extreme pH values in Boundary Creek 1990 to 2008

Natural processes such as severe droughts can also cause a swamp to dry out. However the acidification of "the Big Swamp" happened during a period of higher than normal rainfall. The graph of pH in Boundary Creek versus rainfall (figure 9) shows that the first abnormal acid event occurred in December 1990 with a pH of 4.2 and in January 1991 with a pH of 4.3 followed by a pH of 3.8 in March. These extremely low pH's coincided with the period of very heavy pumping from the Gerangamete Borefield totaling 21,000 Megalitres from 1987 to 1990. This very high extraction rate was designed to "Stress the aquifer" according to the DNRE report.

The graph of rainfall versus pH (figure 9) shows that the years 1990 and 1991 were much wetter than normal rainfall years. In spite of this the pH in Boundary Creek dropped to as low as 3.5 in February 1992 and 3.6 in May 1992. In contrast the pH values in Loves Creek (the control values for pH) remained in the normal range and showed no change over this period.

From December 1990 to December 1996 there was no pumping from the Gerangamete Borefield. Figure 10 is an enlarged plot over this period. In spite of no pumping an extreme pH value of 3.8 was recorded in March 1991. This is despite 1991 being a wetter than average year of 1078 mm which is 74 mm above the long term average. Figure 10 shows that in May 1992 extreme pH values were recorded in May of 3.6 and in June 3.9. This is despite 1992 also being a very much wetter year than average with 1184 mm, 243 mm above average. From 1993 to 1996 the pH levels in Boundary Creek generally recovered to normal with exceptions of very high values in May 1994, March 1995 and March 1996.

Figure 9 shows that in 1997 pumping recommenced and continued through to December 2000 with a total of 36,587 Megalitres extracted. Figure 11 is an enlarged plot of the period from 2000 through to January 2006. In contrast to the period of no pumping in figure 10, the period 2001 to 2006 shows that pH values in Boundary Creek never recovered from very high to extreme except for three individual months in May 2002, November 2003 and September 2004. Figure 9 shows the rainfall for the period from 2000 through to 2004 was also much wetter than average. Figure 9 also shows that the so-called "Millennium Drought" did not start until 2005 with the driest year in 2006. In conclusion figure 9 shows that from 2000 onward the pH in Boundary Creek never recovered to normal values and remained in the extreme acid range of 3.5 to 4.0 for most of the time.

By 2008 "the Big Swamp" had dried out so completely to the extent that it caught fire following a burn off on a neighboring property. It continued to burn underground and reignited surface vegetation causing bushfires in surrounding state forest for several years causing major problems for the CFA.

Worth keeping in.

1997

Top end caught fire from neighboring property burning

1997 - caught fire, then 1998 - same summer caught fire (re ignited)

16 March 2010 reignited in the swamp itself. (4 people witnessed this.)

Conclusion on the cause of the extreme acid events in Boundary Creek

From the above it can be concluded without any doubt that the cause of the very high to extreme acid content of Boundary Creek was caused by high levels of pumping in the Gerangamete Borefield. The high pumping levels from the aquifer caused the water level in the aquifer to drop permanently below "the Big Swamp" thus causing the swamp to dry out and generate high acid sulphate water by a process of oxidation of the pyrite contained in the peat.

It can also be concluded that drought was not a cause of the extreme pH because the first extreme pH's in Boundary Creek appeared in June 1990, 15 years before the "Millennial Drought" commenced in 2005.

Following the four years of pumping from 1987 to 1991 the Boundary Creek had dried out to the extent that the top end of the swamp caught fire in 1997. This was over seven years after the first extreme pH values were observed in Boundary Creek. Pumping had recommenced in 1997 and continued through to 2001. The swamp again caught fire in the summer of 1998 and again in 2010.

It can certainly be concluded that the fires were not a cause of the acid water as the fire post dated the first extreme pH event by seven years..

Borefield Licensing

The DNRE report made several important conclusions with respect to environmental impacts of pumping from the Gerangamete Borefield on the Barongarook High and Boundary Creek.

Environmental Impacts on Recharge Area Streams and Springs

The DNRE, 1996 report concluded that, *"Outcropping aquifer material on the Barongarook High receives recharge in most years that sustains the flow of small springs which feed into the creeks (e.g. Boundary Creek). There is good hydraulic connection between Boundary Creek and the aquifer.*

Significant bore field development will lower water levels on the Barongarook High and impact on Boundary Creek and it is possible that the creek and some springs may exhibit reduced flows in the summer and autumn periods.

The impact on springs will vary depending upon the location and the degree to which the spring is perched above the water table. Springs connected to the regional groundwater system near the edge of the graben are likely to become intermittent and remain so for prolonged periods after significant extraction events.

It is estimated that watertable recovery along the western edge of the graben may take several years depending on the amount of extraction". (DNRE report Page 132).

Modelling Results

The DNRE report concluded that, "*Modelling has highlighted several features of the Barwon Downs graben".* Most significantly the report concluded that, *"The mean annual recharge from precipitation is relatively small and increases from about 1500 ML/year in the undisturbed state to about 4000 ML/year under stressed conditions. This enhanced recharge is largely derived from increased surface water infiltration and interception of groundwater inflows to Boundary Creek and spring systems on the Barongarook High".* (DNRE report Page 122).

The DNRE report further concluded that, *"Any significant development of the groundwater resource (i.e. greater than 1500 ML/year), will result in the watertable being lowered on the Barongarook High and will have an impact on the Boundary Creek and associated spring systems because of the high degree of hydraulic connection that exists between the aquifer system in the graben and aquifer outcrop on the Barongarook High".* (DNRE report Page 123)

DNRE Borefield licensing recommendation

At the time of writing the DNRE, 1996 report Barwon Water had a Licence to extract 12,600 ML per year as follows. *"Barwon Water has a licence to extract up to 12,600 ML/year and no more than 80,000 ML over a ten year period, that is, a long term (over a ten year period) average of 8,000 ML/year".* It is not at all clear in any of the available reports how SRW arrived at the original average licence of 8,000 ML per year or the maximum figure of 12,600 ML per year.

Following the pumping period 1887 1987 to end 1990 and based on all of the studies conducted by the DNRE (geological mapping, hydrology, hydrogeology, analysis of hydrographs and mathematical modeling) the DNRE report recommended the Barwon water Licence be significantly revised downwards (from 12,600 ML per year or a maximum of 80,000 ML over 10 years) as follows.

"The results of the investigation and modelling suggest that, based on the recharge and drawdown criteria, that the basin can be licenced for an estimated average annual volume of at least 4000 ML/year, however this may be revised upward if artificial recharge is practiced". It should be noted that at no stage has Barwon Water attempted artificial recharge of the aquifer.

However this recommendation by the DNRE was a qualified recommendation and it consists of two components.

1. A natural recharge component of 1500 ML per year. This is the sustainable extraction that can be achieved without stressing the intake area.
2. A stressed component of 2500 ML per year. This is the additional component of groundwater that can be extracted from the aquifer by stressing the aquifer by over-pumping of the Borefield as stated by DNRE above. *"This enhanced recharge is largely derived from increased surface water infiltration and interception of groundwater inflows to Boundary Creek and spring systems on the Barongarook High"*. And further *"will result in the watertable being lowered on the Barongarook High and will have an impact on the Boundary Creek and associated spring systems because of the high degree of hydraulic connection that exists between the aquifer system in the graben and aquifer outcrop on the Barongarook High"*

The DNRE aquifer model also quantified the volume of stream flow in the Boundary Creek gained from the aquifer as follows. *"Further, the model shows that groundwater flow from the intake area towards the graben is intercepted by Boundary Creek, which acts as a gaining stream receiving discharge of approximately 3.5 ML/day"*. (DNRE report Page 87).

A gain in flow of 3.5 ML/day is equal to 1277 ML/year. This is the "unstressed flow" from the Boundary Creek that would normally contribute an average environmental flow into the Barwon River of 1277 ML/year continuously over time.

A further inference can be drawn from the DNRE modeling result. The "*stressed component of 2500 ML per year*" is made up of 1277 ML from the natural gain from the aquifer to the stream plus a further 1223 ML per year, which is caused by diverting natural rainfall runoff that would normally flow into the Boundary Creek (and then to the Barwon River), into the aquifer. This second component is caused by the drop in the water table in the aquifer caused by pumping from the Gerangamete Borefield. The drop in the water tables over the whole Barongarook intake area induces increased infiltration into the aquifer that is then diverted to and extracted from the Borefield.

The stressed component is actually much greater than the 2,500 ML per year allowed for in the DNRE, 1996 report.

The Southern Rural Water (SRW) 1996 Borefield Licence

It is quite clear that the SRW licence of *"12,600 ML/year and no more than 80,000 ML over a ten year period, that is, a long term (over a ten year period) average of 8,000 ML/year"* completely ignored the recommendations of the DNRE report. In awarding a licence of 8000 ML per year, SRW effectively made a decision to Licence 1,500 ML per year, which is equivalent to the entire average sustainable recharge to the Early Tertiary aquifer over the Barongarook High intake area, estimated by the DNRE.

SRW also effectively made a decision to licence a further 6,500 ML per year (compared to the 2,500 ML per year allowed for in the DNRE report) from the surface water runoff from the Barongarook High to Barwon Water. This decision to allocate the extra 6,500 ML per year was made in the full knowledge of the environmental effects detailed in the DNRE report and referred to above. (This decision was compounded and the licence was subsequently revised even higher, see below).

This licence to Barwon Water also effectively excluded any landowners or communities in the Barwon River catchment from accessing the Early Tertiary aquifer because it allocated the full sustainable recharge rate to Barwon Water. This put the interests of the Geelong clients of Barwon Water ahead of the interests and water entitlements of Barwon River catchment landowners. AND environment. (Aware of this in 1986 ie Q. farmer Bowers work)

The following observation can be made. There is absolutely no difference in practice between issuing a Licence for the Borefield of 1,500 ML per year and issuing a surface water licence of 6500 ML per year from the Barongarook High and Boundary Creek. In other words, the same result could have been achieved by pumping 1,500 ML per year from the Borefield and by putting a dam across the Boundary Creek above the confluence with the Barwon River, and piping (or pumping) 6,500 ML per year from the dam to the Upper Barwon – Wurdee Bolac channel.

A second observation can be made. If SRW had made the second decision (i.e. to dam the Boundary Creek) there would have been a requirement for a full Environmental Impact Statement (EIS). This would have required input from other Government agencies regarding its impacts and allowed for general public input, including affected landowners and other stakeholders in the Barwon River catchment, into the decision.

A third observation can be made. By licensing the additional 6,500 ML per year to the Gerangamete Borefield, SRW effectively removed the contribution of the long-term sustainable flow of 6,500 ML per year of the Boundary Creek, from the long-term sustainable environmental flow of the Barwon River. The SRW licence therefor effectively bypassed any review of the environmental or sustainable flows of the Boundary Creek and Barwon River that would have normally been a legislative requirement of the Water Act of Victoria.

Did it again in 2004. Otway Water BK 30 "Sick of Hearg That."

The Southern Rural Water (SRW) current Borefield Licence

At the time of writing the DNRE report (1996) Barwon Water had a Licence to extract 12,600 ML per year as follows. *"Barwon Water has a licence to extract up to 12,600 ML/year and no more than 80,000 ML over a ten year period, that is, a long term (over a ten year period) average of 8,000 ML/year".*

Subsequent to 1996, SRW increased the Gerangamete Borefield licence in 2004. The current Borefield Licence issued by SRW to Barwon Water is for 20 000 ML per year (or

80 000 ML in 10 years or 400,000 ML in 100 years). This is a massive and extraordinary increase on the licence as it stood in 1996.

There is no publically available information to support such a massive increase. From a technical perspective it is simply not credible that there should be such a great disparity between the two licenses issued by SRW (i.e. that in 1996 and the current licence). To support such a massive increase in the licence in 2004 there must have been further independent studies available to SRW, such as further aquifer recharge studies or further aquifer modeling. To be credible these further studies should have presented new data and detailed the reasons why the DNRE, 1996 estimates were wrong. However no such studies to support such a massive increase are publically available.

The DNRE, 1996 report is still the current most definitive published report on the sustainable recharge, and therefor the sustainable volume for the Borefield licence. No independent studies by Barwon Water (or its consultants) or any government agency is publically available which supports a sustainable aquifer recharge of greater than 1,500 ML per year over the long term.

Volume pumped from the Borefield compared to the Sustainable Recharge

Figure 3 shows the total volume of water pumped from the Gerangamete Borefield. Over the 27-year period from 1983 to 2010 a total volume of 122,358 ML was pumped from the Borefield. There were four main pumping events. In 1983 a volume of 8100 ML was pumped, from 1987 to 1990 a volume of 22,888 Ml was pumped, from 1997 to 2000 a volume of 36,587 ML was pumped and from 2005 to 2010 a volume of 52,683 ML was pumped. This is equal to an average of 4539 ML per year over the 27-year period.

This total extraction can be compared to the total sustainable (i.e. "non stressed") intake of 40,500 ML (i.e. 27 times 1500 ML) over the same 27-year period.

The total volume extracted of 122,358 ML was therefore 3.03 times the total sustainable recharge of 40,500 ML over the Barongarook High intake area over the 27-year period. It can be concluded that it is of no surprise that the Boundary Creek and Barwon River have responded in the way they have to this massive over exploitation of the groundwater resource.

MINING

This over exploitation is equivalent to "mining" the groundwater resource. Such an over exploitation of the groundwater resource is not in compliance with the Water Act of Victoria, which is quite specific in that the requirement for the development of both surface and groundwater must be undertaken in a sustainable manner.

SEPP Acts not followed. etc.

Groundwater Consultants to Barwon Water

The groundwater consultants to Barwon Water (SKM now Jacobs) have long maintained that the sustainable yield from the Barwon Downs Borefield is vastly greater than the DNRE estimate (reportedly up to 20,000 ML per year compared to 1500 ML per year, or

by a factor of over seven times that of the DNRE estimate). The consultants have never made available the basis on which their calculations are based.

In light of the environmental outcomes in the Boundary Creek and the Barwon River, and the conclusions drawn from these outcomes as detailed above, Barwon Water should make the consultants report and the basis on which their estimates are made public. It would appear that these estimates might be considered "commercial in confidence" by Barwon Water and Barwon Water does not wish to release the basis on which the estimates are made.

The public, including the landowners and stakeholders in the Barwon River catchment, have to accept the consultant's conclusions without any independent analysis. Although mathematical models may vary, discrepancies between mathematical models should only be of the order of 10 to 20 percent. A variation of 700 percent between models is simply not credible from a technical viewpoint.

It can be concluded that an independent technical audit of the consultant's estimates (if in fact the consultants maintain the figures) should be undertaken in order to determine the reason for the extraordinary discrepancy between the consultant's estimates of sustainable yield compared to those of the DNRE. The commissioning of the independent audit should be by the relevant authorities, principally SRW responsible for the determination of the Borefield licence, with input from the CCMA and Barwon Catchment stakeholders.

Appendix A

Chemistry of the generation of acid sulphate water

When any formation containing sulphides such as pyrite is exposed to water and oxygen, acid sulphate water is produced. The formation can include the wastes from sulphide mineral deposits, waste from coal mines (coals contains pyrite) or, as in the case of the Boundary Creek peat deposit, exposure of the pyrite in the peat to oxygen and water.

When pyrite is exposed to water and oxygen, it reacts to form sulphuric acid (H_2SO_4). The following oxidation and reduction reactions express the breakdown of pyrite that leads to acid sulphate water (Cotf.edu, 2004).

1. $2FeS_2 + 7O_2 + 2H_2O = 2FeSO_4 + 2H_2SO_4$
2. $2Fe^{2+} + 1/2\ O_2 + 2H^+ = 2Fe^{3+} + H_2O$
3. $Fe^{3+} + 3H_2O = Fe(OH)_3 + 3H^+$
4. $FeS_2\ (s) + 15/4\ O_2 + 7/2\ H_2O = 4H^+ + 2SO_4 + Fe(OH)_3\ (s)$

Sulphuric acid (H_2SO_4) and limonite (or ferrous hydroxide $Fe(OH)_3$ commonly known as yellow or red ochre) are therefor the products of the breakdown of pyrite when exposed to water and oxygen. The formation of acid sulphate water, although common, is not generally a normal or natural process. It generally results from man made processes such as metal sulphide mining, or coal mining, bringing pyrite to the surface where it is exposed to water and oxygen.

The exposure of the pyrite in the peat in "the Big Swamp" was also not a natural occurrence. It resulted from the dropping of the water table beneath the swamp by over pumping from the Gerangamete Borefield.

Stability-field diagram for the aqueous ferric-ferrous system

The stability-field diagram of the ferric-ferrous system for aqueous solutions has been published in the USGS Water Supply Paper Number 1459 (USGS, 1962). Figure 1 is a stability-field diagram for dilute solutions of iron taken from figure 1 of Hem and Cropper, 1962 in the Water Supply paper.

The left hand axis is a measure of the oxygen concentration increasing to the top, or Eh measured in volts and the horizontal axis is the pH, or hydrogen ion concentration. At the top of the diagram the vertical boundaries between the

different species of iron in solution are independent of Eh, i.e. they are vertical and dependent on the ph.

On the diagram two water samples that would be representative of "the Big Swamp" under different oxygen saturations are plotted. Sample one is representative of the Eh and pH conditions when the swamp is fully saturated and therefor in the reduced (low oxygen) state. In sample one the neutral pH and low oxygen concentration results in pyrite being deposited in the peat. Sample two is representative of the conditions when the swamp has dried out and intermittently wet and dry and is oxidised. When the swamp is oxidised limonite (iron hydroxide) is the iron mineral phase in equilibrium with the water and limonite is deposited from the highly acidic water. The detailed chemical reactions are included below.

At the top of the diagram the pH boundaries between the different ferric species in solution are calculated from thermodynamic computations based on the equilibrium constants for each reaction and the activity of the hydroxide ion (OH^-).

Thus the boundary for equation 1 occurs at a pH 2.4.

$$FeOH^{++} <- -> Fe^{+++} + OH^- \quad \ldots\ldots \text{Eq. 1}$$

The boundary for equation 2 occurs at a pH 4.6.

$$Fe(OH)_2^+ <- -> FeOH^{++} + OH^- \quad \ldots\ldots \text{Eq. 2}$$

And the boundary for equation 3 occurs at a pH 4.8.

$$Fe(OH)_3\ (c) < - -> Fe(OH)_2^+ + OH^- \quad \ldots\ldots \text{Eq. 3}$$

Limonite, $FeO(OH).\ nH_2O$, commonly known as yellow ochre, is precipitated from the oxidation of peat bogs. On figure 1 limonite is the stable form of iron oxide precipitated from the reactions 1,2 and 3 above over the pH range 2.4 to 5.0.

Limonite is an iron ore consisting of a mixture of hydrated iron(III) oxide-hydroxides in varying composition. The generic formula is frequently written as FeO(OH)·nH2O, although this is not entirely accurate as the ratio of oxide to hydroxide can vary quite widely. Limonite is named from the Greek word for meadow, in allusion to its occurrence as bog iron ore in meadows and marshes. (Wikipedia, 2017)

Following oxidation the pyrite is converted to limonite and the water flowing out of "the Big Swamp" is highly acidic (from reactions 1 to 4 above) and from equations 1 to 3, and limonite is the iron mineral deposited downstream of the Big Swamp.

Treatment of acid sulphate waters

In Mining leases where acid sulphate waters are produced the water must be treated to increase the pH and remove heavy metals before discharging to streams. Treatment commonly consists of adding strong bases such as caustic soda (NaOH or sodium hydroxide), soda ash (Na_2CO_3 or sodium carbonate), or lime (CaO or calcium oxide).

An obvious conclusion is that, if the water from Boundary Creek originated on a mine site, Victorian Government EPA regulations would require that it also would have to be treated for pH and heavy metals before releasing into a river such as the Barwon River.

References

DNRE, 1996. Groundwater development options and environmental impacts Barwon Downs graben, south western Victoria, Witebsky, Sue, Chandrika Jayatilaka, Andrew Shugg. Victoria Department of Conservation and Natural Resources, East Melbourne, 1996

USGS, 1962 The Chemistry of Iron in Natural Water. Geological Survey Water-Supply Paper 1459. United States Government Printing Office, Washington : 1962

Cotf.edu, 2004 http://www.cotf.edu/ete/modules/waterq/wqhardness.html

Wikipedia, 2017 https://en.wikipedia.org/wiki/Limonite

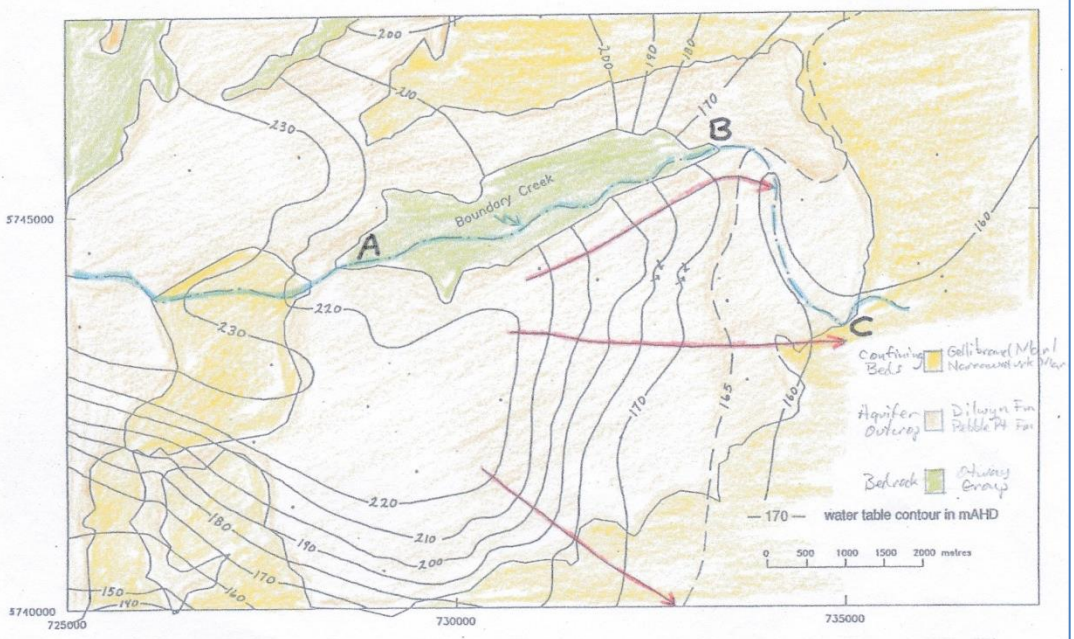


Figure 1. Original Water table contour map of the Barongarook High Intake area (after Figure 21, DNRE 1990)

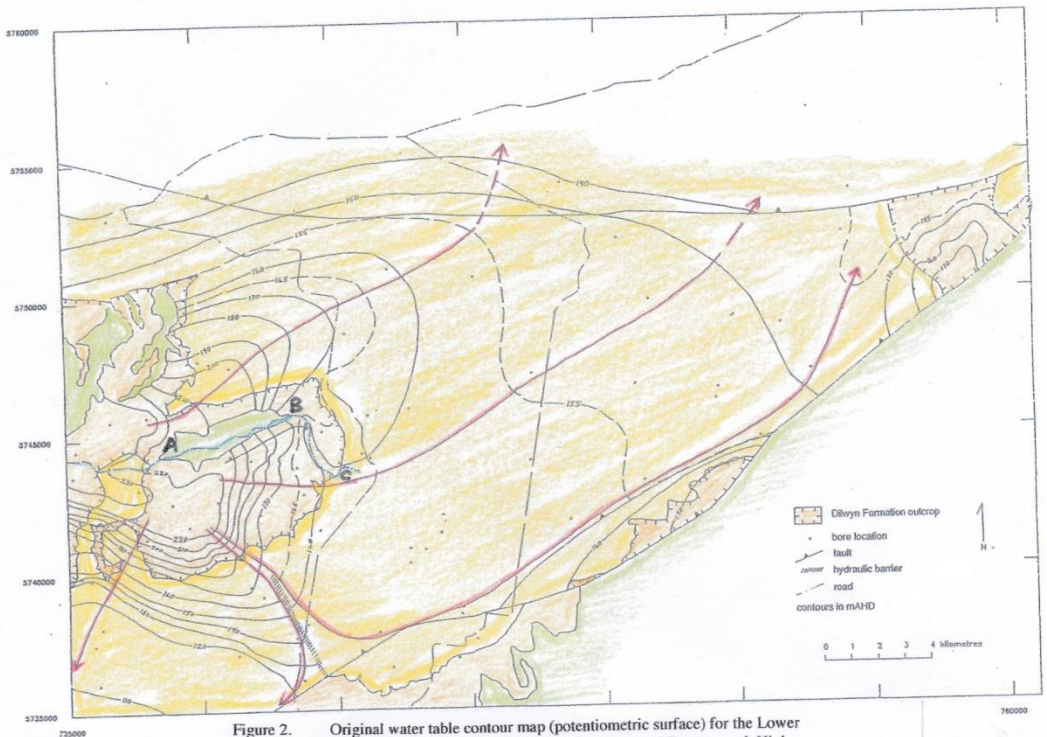


Figure 2. Original water table contour map (potentiometric surface) for the Lower Tertiary aquifer on 26 February 1990, Barwon Downs Graben and Barongarook High (after Figure 22, DNRE 1990)

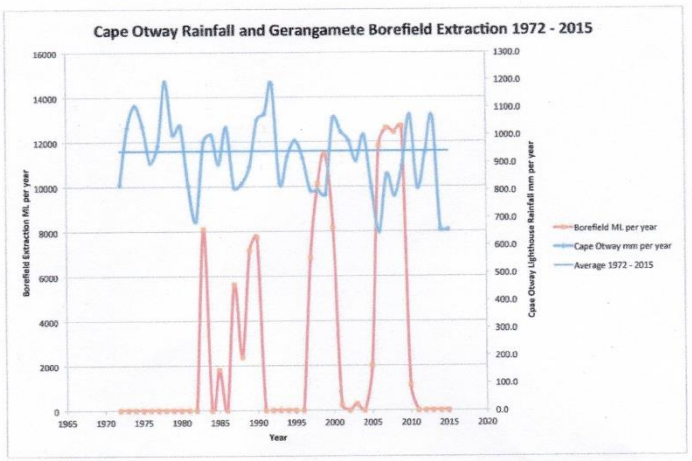


Figure 3. Cape Otway Lighthouse Rainfall and Gerangamete Borefield extraction, 1972 to 2015

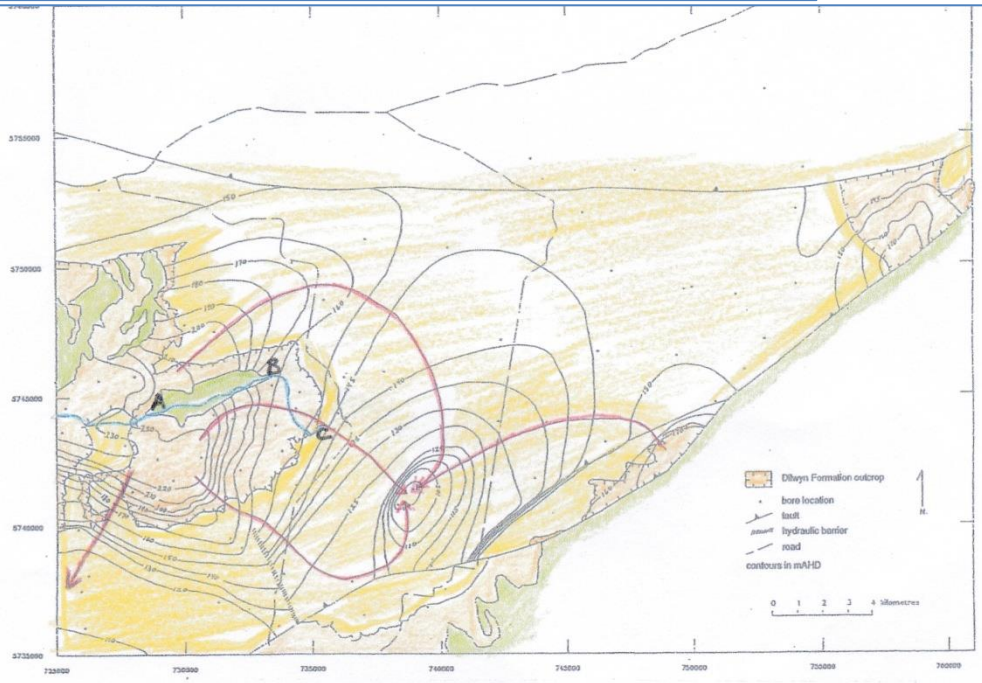


Figure 4. Water table contour map (potentiometric surface) for the Lower Tertiary aquifer on 15 February 1987, Barwon Downs Graben and Barongarook High (after Figure 24, DNRE 1990)

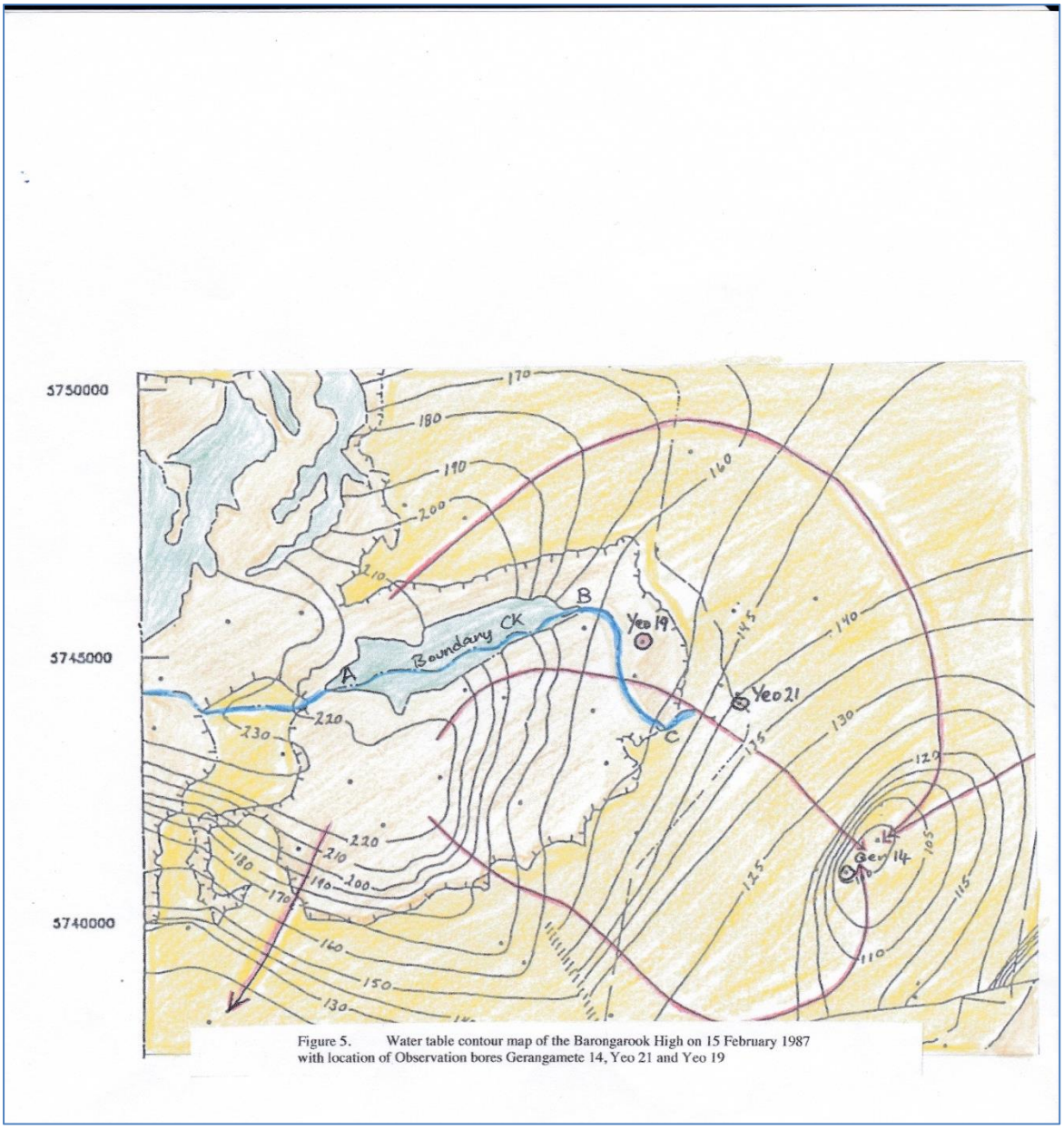


Figure 5. Water table contour map of the Barongarook High on 15 February 1987 with location of Observation bores Gerangamete 14, Yeo 21 and Yeo 19

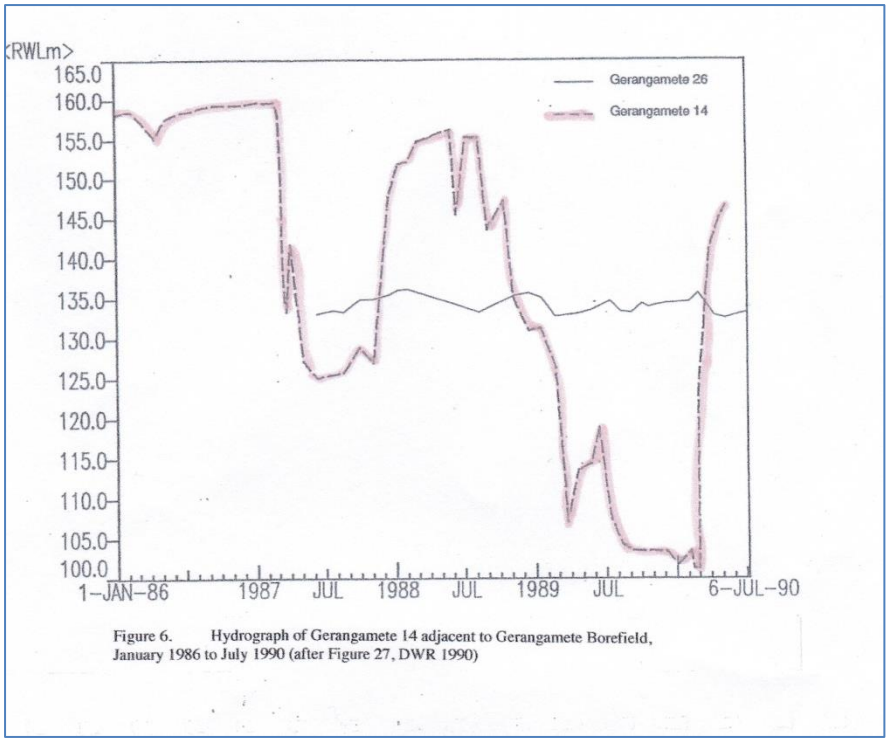


Figure 6. Hydrograph of Gerangamete 14 adjacent to Gerangamete Borefield, January 1986 to July 1990 (after Figure 27, DWR 1990)

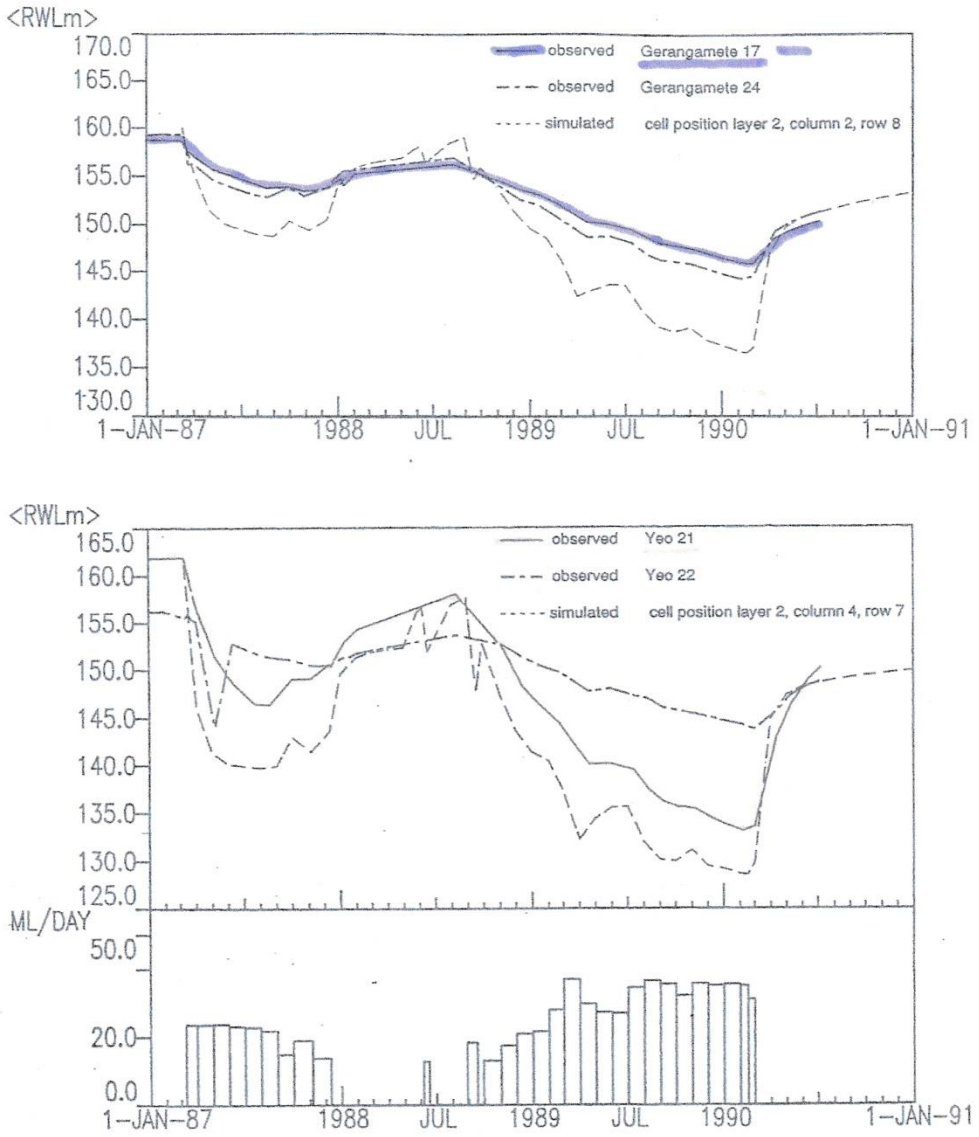


Figure 7. Hydrograph of Yeo 21 adjacent to Boundary Creek on the Colac-Forrest Road, January 1986 to July 1990 (after Figure 48, DNRE 1990)

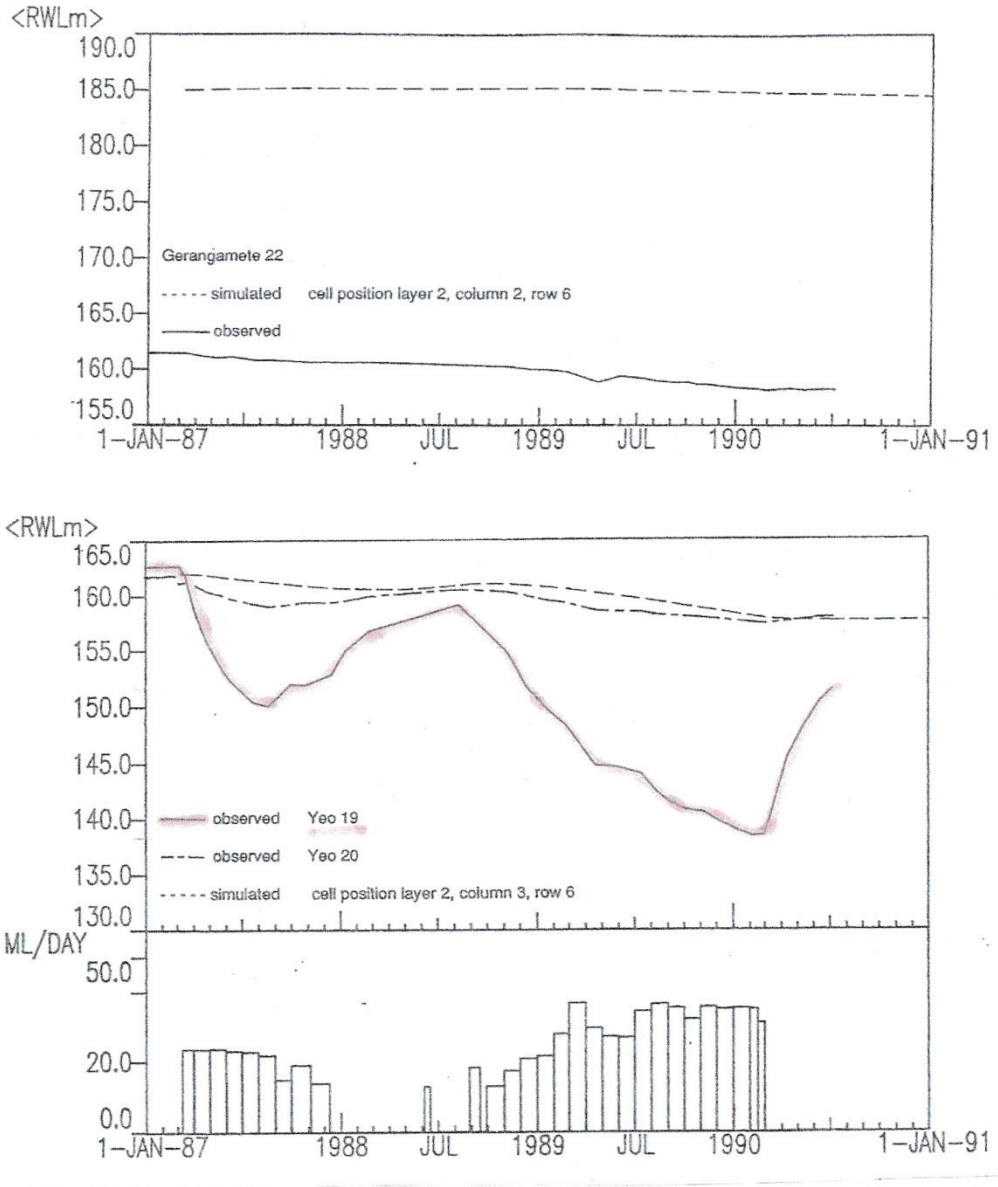


Figure 8. Hydrograph of Yeo 19 adjacent to Boundary Creek and "the Big Swamp", January 1986 to July 1990 (after Figure 48, DNRE 1990)

(b) Yeo 19/20

Roger researched the rainfall for this period using Colac's rainfall & found it an extremely wet period - see Otway Water BK 19 Page 30

1990 1997

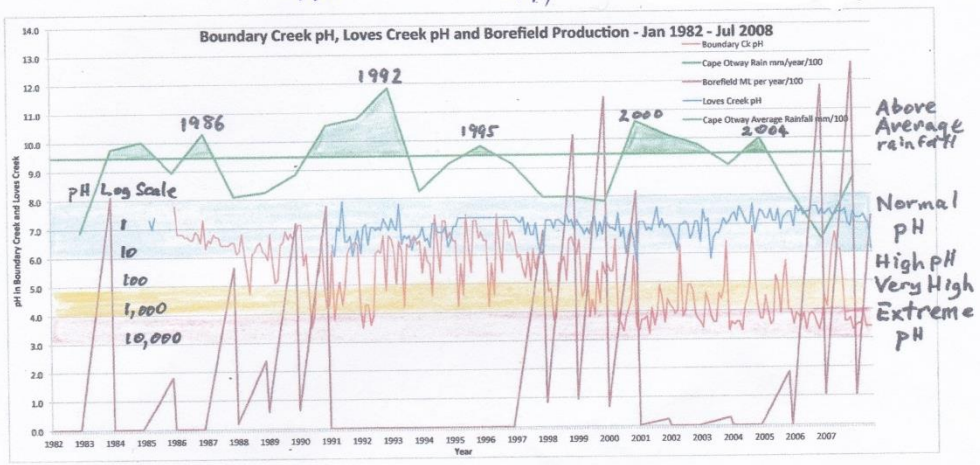


Figure 9. Boundary Creek pH, Loves Creek pH, average yearly rainfall Cape Otway and Gerangamete Borefield extraction (cumulative monthly pumping per year in ML), 1982 to 2008

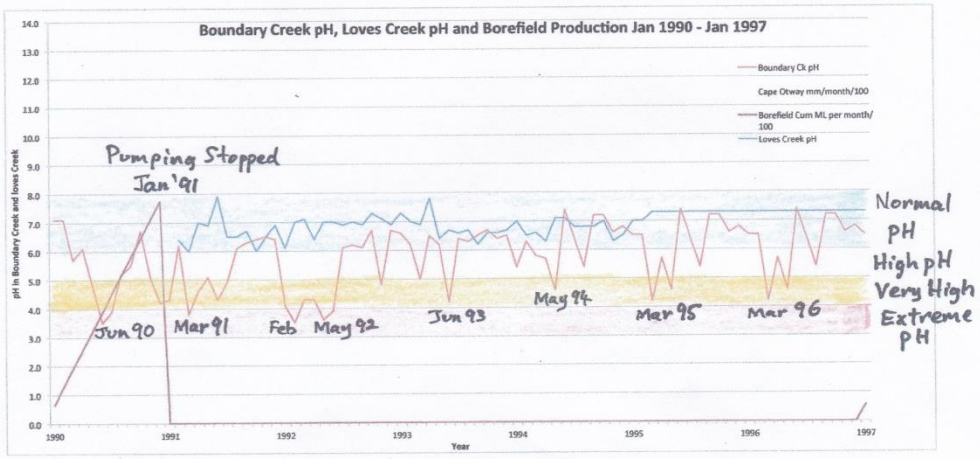


Figure 10. Boundary Creek pH and Loves Creek pH, period of no pumping from Borefield, January 1991 to December 1996

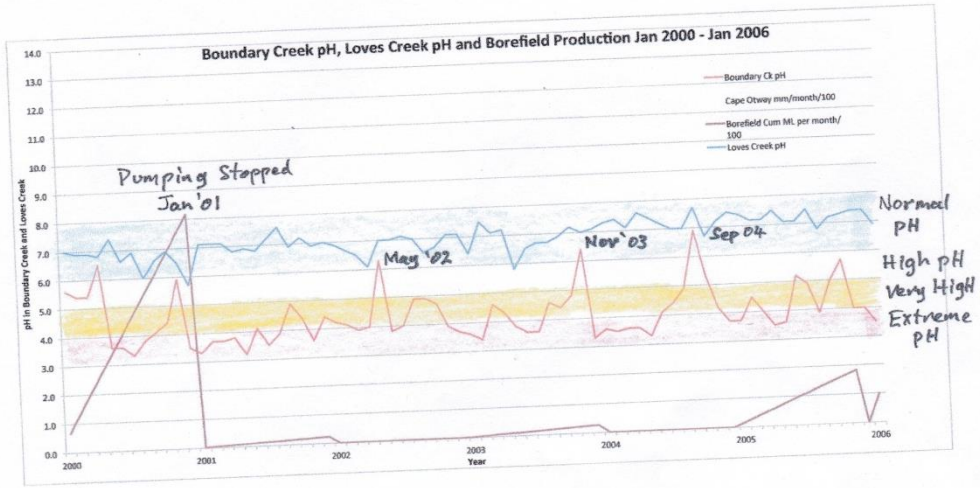


Figure 11. Boundary Creek pH and Loves Creek pH, period of no (or minimal) pumping from Borefield, January 2001 to January 2006

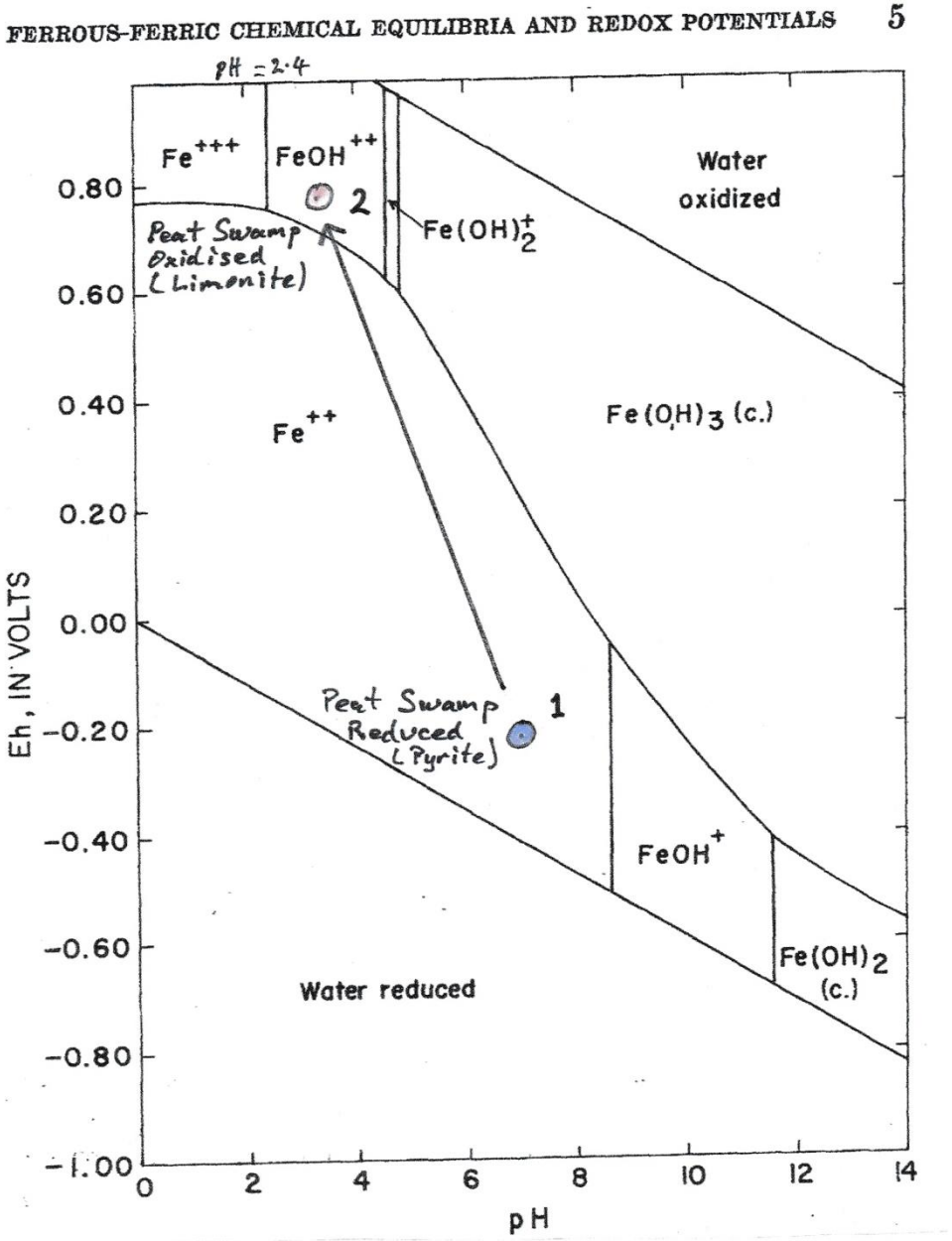


Figure 12. Stability-field diagram for aqueous ferric-ferrous system

SECTION TWO.

LAWROC Landcare Group commissioned me to prepare a report on vegetation studies (see Otway Water Book 31) done in relation to groundwater extraction from the Barwon Downs Borefield between 1986 and 2016. Part of this report included a multitude of critical mistakes that have been made in the Barwon Downs Borefield reports. During the write up period of Book 31, I contacted by phone, a Barwon Water representative with two of these concerns.

1. How is it possible that so many people can be involved in the preparation of reports and miss so many mistakes?
2. Are the co-ordinates/grid references of the vegetation sites in Jacobs' "Barwon Downs Vegetation Monitoring," 7 July 2015 correct?. This report was prepared as part of Barwon Water's obligations under the groundwater extraction licence conditions.

Jacobs were asked by Barwon Water to clarify the correctness of the co-ordinates. The reply, via Barwon Water, arrived soon afterwards.

On Friday, March 31, 2017, 11:25, [redacted] <[redacted]@barwonwater.vic.gov.au> wrote:

Hi Malcolm,

I have followed up on the concern you raised around the accuracy of the coordinates used for the 2016 vegetation baseline survey. The concern you had was that all the vegetation site coordinates in the report did not match the coordinates set out in the groundwater licence for the amended vegetation sites.

Jacobs have checked the coordinates and they are correct, they are just presented in different MGA zones. The coordinates in the licence are presented in Zone 55 and the coordinates in the report are in Zone 54. The latitudes and longitudes presented in the report are the same regardless of the MGA zone.

If you have any questions, please give me a ring.
Thanks,

Jacobs must not have checked the co-ordinates as the incorrect labelling of the ZONE was not a problem. In one instance three sites had the same co-ordinates; another two sites had the same co-ordinates as did another two. In the instance of the three sites with the same grid references there were distances between sites of over 5 kilometres. Confusion over the Zone had already been noted by me but as explained by Jacobs this was minor compared to the mistakes with the wrong co-ordinates. Referring to "Z54" as "S55" made little difference. However, this mistake is another example of sub standard work.

For Jacobs to say that they checked the co-ordinates and they are correct, reinforces the degree of sub standard work on someone's part.

At a Boundary Creek Landholders meeting with Barwon Water representatives it was pointed out that the Jacobs' grid reference checking had not resolved the mistakes. At this meeting other possible mistakes were pointed out to the BW representatives and this prompted the following email.

On Tuesday, May 2, 2017, 09:40, Rhys Bennett <Rhys.Bennett@barwonwater.vic.gov.au> wrote:

Hi Malcolm,

Thanks for attending the meeting held on the 21st of April to discuss options for provision of stock and domestic flow in the lower reaches of Boundary Creek.
The meeting provided us with a better understanding of the needs and priorities of the landholders, which was a good outcome.

In the meeting, you raised concerns about inaccuracies in the technical reports related to the monitoring program. Jo and I would like to organise a time which suits you to come down and discuss your concerns. We are on the same page as you in wanting the content of the reports to be as accurate as possible.

Please let me know when and where would suit you best.

Thanks,
Rhys

Rhys Bennett
Co-ordinator Network Planning I Barwon Water
49-51 Malop Street *(Temporary Office)* Geelong VIC 3220
T (03) 5226 2328 I M 0410 302 708 I W www.barwonwater.vic.gov.au

My reply below, is self explanatory.

Hello Rhys,
Kay and I are off to Italy Sunday and there wil be little time before then to meet. Also the work I have referred to has been commissioned by LAWROC and you probably need to ask Tricia Jukes (President of LAWROC) whether I can discuss this work . I perhaps have said too much already without LAWROC permission.
Anyway it would be a good idea to approach Tricia. Phone 52358298.
Cheers,
Malcolm.

On 4 May 2017 the meeting between Roger Blake, Jim Lidgerwood, myself and Tracey Slatter and Jo Plummer took place at which time the same mistakes were presented. The LAWROC executive had decided that no further discussion on other possible mistakes would take place until the current ones

had been answered satisfactorily. (The next 3 pages include my summary of the meeting with Tracey and Jo Plummer.)

4 May 2017 meeting at 55 Mercer Street Barwon Water offices in Geelong between:

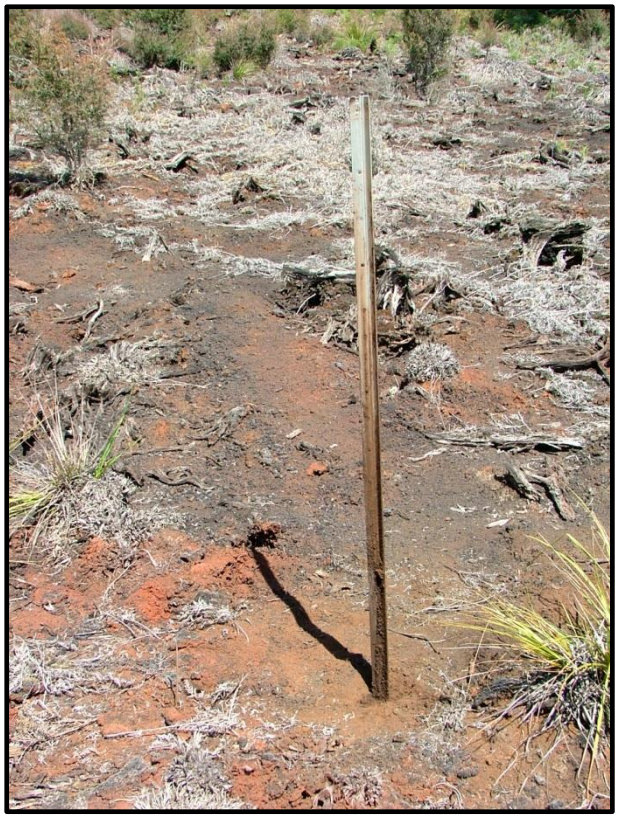
Roger Blake, Jim Lidgerwood and Malcolm Gardiner,

Tracey Slatter, Jo Plummer and note taker Jennifer (hope I have Jennifer's name right).

To the Executive of LAWROC Landcare Inc. Group.

The following comments are some of my (as the LAWROC representative) recollections and thoughts regarding this meeting.
Tracey will also be sending out copies of minutes taken by her note taker.

*Tracey provided two copies of the 2009 Vegetation Report that was completed as per the 2004 licence conditions. This was in response to asking BW for the Carr/SKMs results of their visit to the Big Swamp. SRW made an assurance that this would be done. The 2009 report states "**In one area, not forming part of this study, there was circumstantial evidence of acid sulphate soils possible impacting on vegetation.**" No other comments in the report. What was requested of Tracey was the detail of observations made when this "one area" was visited. This area was the Big Swamp wetlands and as Carr/SKM had placed a galvanised dropper in this site it is reasonable to assume notes were taken.*



Photos taken 21 January 2009.

Tracey doubted there would be any record of the observations but would check. However, the scene at the Big Swamp would still be etched into the minds of the people who visited this site and their comments etc. could still be noted and recorded.

After this was sorted out Roger tabled a letter written by Joan McKenzie and then gave an excellent explanation of his report speaking logically and succinctly when presenting his compilation of facts, data and interpretation. His presentation left no doubt in my mind that he has the background, expertise, knowledge and material to support his argument that the extraction of groundwater at the Barwon Downs Borefield has been a mining operation.

(Joan Mc is responsible for initiating the whole process, starting at a meeting she organised in Winchelsea at which Richard Riordan(MP) and Simon Ramsey(MP) attended. Joan kept minutes and followed up with a meeting in Colac that included a deputation of six people talking with Richard. This prompted the setting up of the 4 May 2017 meeting with Tracey Slatter and Jo Plummer in Geelong.)

I spoke about LAWROC's concerns that it appears Jacobs is setting new baseline data from 2014 ignoring the historical and very things Roger spoke about in his presentation. This was viewed as highly unlikely.

Tracey and Jo gave assurances that they most definitely did not want to see any environmental damage being done as a result of groundwater extraction on their watch, and, that every effort will be made to ensure that this does not happen. Barwon Water is paying lots of money to Jacobs in an effort to gain sound advice. Emphasising the importance placed on this assurance the meeting ran 1 hour 20 minutes longer than scheduled.

The outcomes as I see them, are:

1. *Tracey will have another look at seeing whether there are any details/report made on the visit to the Big Swamp wetlands in 2008.*
2. *Tracey and Jo made assurances that they will pursue and ensure that sound processes are put in place following up Roger's report.*
3. *The application for renewal of the groundwater extraction licence will go ahead as planned.*
4. *BW will ask as part of this application, that SRW audits and reviews their application.*

5. *The three mistakes in the 2014-15 vegetation report that have already been pointed out to BW by LAWROC through Jo Lee and Rhys Bennet, will be looked into. Namely:*
    a. *Site co-ordinates of many of the sites appear to be incorrect.*
    b. *The Big Swamp map and description are wrong.*
    c. *Local input timeline is wrong.*
6. *LAWROC not prepared to disclose other mistakes in the vegetation reports until these three issues are resolved.*

A most worthwhile meeting with the expectation that "things" will change.

<u>For the LAWROC executive to consider and discuss at its next meeting:</u>
a. Allow some time for these good things to eventuate from this 4 May 2017 meeting.
b. A first step towards a trust relationship with BW will be established when BW follows up on investigating the three mistakes ((and if found to be correct, have the corrections put in writing)).
c. Note that Roger Blake is a strong advocate for truth, honesty and integrity. Integrity based on verifiable data.
d. Note that Jim is an excellent co-ordinator/catalyst and tireless worker being able to inform and draw together authorities, people and groups passionately concerned for the Barwon River's welfare.
e. LAWROC to continue to provide support for, and communication with the Winchelsea people. Their problems are or will be our problems and issues if things do not change.

Malcolm.

Tricia, as LAWROC President, was approached by Barwon Water regarding mistakes in Jacobs' work. It was decided by the Group that until the mistakes already pointed out are resolved, that other problems with Jacobs' reports would have to wait. Considering the number of 5 "experts" that had passed these reports, and the fact that Barwon Water has consistently backed Jacobs' work as being rigorously and technically correct, LAWROC Landcare Group was prepared to wait for Jacobs' reply. Amazingly, Southern Rural Water had also accepted the 2015 report without correction.
Once again Jacob's was asked to clarify things:

- site co-ordinate mistakes,
- the map and site description of the Big Swamp, and

- the timeline diagram showing the community consultation process.

Jacobs' explanation for the mistakes made arrived early June 2017 with this covering email.

To: 'Kobaust' <kobaust@bigpond.com>
Cc: 'Mal Gardiner' <otwaywater@yahoo.com.au>
Subject: Vegetation report

Hi Tricia,

We have had clarification from Jacobs about the mistakes LAWROC had identified in the recent report. Jacobs are the consultants we engaged to carry out the vegetation surveys,

Please see summarised responses under each item below. For more detail please refer to the file note attached.

a. *Site co-ordinates of many of the sites appear to be incorrect.*
Typo errors were confirmed in the 2015 report where the co-ordinates for five vegetation sites did not match the co-ordinates in the 2016 report. Jacobs has assured us that although typos were picked up, it doesn't affect either the methodology or the findings of the vegetation survey because the correct co-ordinates were used when the physical surveys were carried out.

We will issue an addendum to the 2015 report with the correct co-ordinates.

Jacobs have also provided explanation about why four vegetation sites (TB3, TB4, TB13, TB14) ended up being located slightly differently to the original location proposed. This was due to access issues and the need for the site to be positioned as close as possible to a groundwater monitoring bore as well as where data would be most useful to assess changes, such as at the edge of a groundwater dependent ecosystem. Maps of each transect to show the proposed location and the actual location can be found in the file note.

b. *The Big Swamp map and description are wrong.*
The report uses a standard government map layer available to the public that approximates the creek line running through Big Swamp. Jacobs has confirmed that while the map layer is simplistic in nature and doesn't account for the complexity of the area, this doesn't affect the vegetation analysis because it is based on field inspections. The actual topography of the swamp (including the creek line and the trenches) has been the basis of all technical work completed to date.

c. *Local input timeline is wrong.*
This diagram has been updated to reflect the input of the Community Reference Group and agency stakeholders separately across different time scales. Where this diagram is in other reports, we have replaced it with the revised version.

Yet to see the revisions.

Thank you again for pointing out these mistakes, it has helped make a better, more accurate version of the vegetation report.
We would like to assure you and members of LAWROC, that we have great confidence that the monitoring program is scientifically rigorous, and comprehensive enough to answer questions that the community have raised.

Once you have had time to read over the file note and discuss the responses with the other LAWROC members, please let me know how you wish to proceed with sharing the rest of the report with us.

See page 53 for LAWROC's reply.

I'll be in touch, thanks-
Jo

Joanna Lee
Senior Engineer, Water Resources Planning I Barwon Water
49-51 Malop Street I P.O. Box 659, Geelong, Victoria 3220
T (03) 5226 2471 I F (03) 5226 1716 I W www.barwonwater.vic.gov.au

A summary of Jacobs' reply.

JACOBS

Memorandum

Floor 11, 452 Flinders Street
Melbourne VIC 3000
PO Box 312, Flinders Lane
Melbourne VIC 8009 Australia
T +61 3 8668 3000
F +61 3 8668 3001
www.jacobs.com

Subject	**Response to feedback provided on the Barwon Downs Vegetation Report 2016 by LAWROC**	**Project Name**	Barwon Downs Technical Works Program
Attention	Jo Lee	**Project No.**	IS191000
From	Louise Lennon		
Date	5 June 2017		
Copies to	Rhys Bennett		

1. Purpose

The purpose of this Memo is to answer LAWROC's questions regarding the Barwon Downs Vegetation Survey 2016 report (Jacobs, 2016), as requested in an email dated 29th May 2016.

LAWROC raised three concerns in the email:

a) *Site co-ordinates of many of the sites appear to be incorrect.*
b) *The Big Swamp map and description are wrong.*
c) *Local input timeline is wrong.*

Jacobs was requested to respond to points a) and b) and our response is provided below.

2. Summary of Response

2.1 Site Coordinates

The coordinates of the vegetation transects have been reviewed and we have found that the vegetation transects have been located appropriately and that data from transects is complete and correct.

We have identified typographic errors in the summary figures on our 2015 report where by coordinates were not correctly reported. The actual site coordinates used in the analysis were correct.

There are differences in the reported coordinates because of the different reporting points and methods. Whilst these are difficult to follow, there is no error in the data that was analysed and thus there is no error in the findings.

2.2 Big Swamp Map

In Jacobs reports we use a standard government published map layer to represent the swamp. We understand that the creek line and the swamp area are more complex than shown in the government published maps. The representations are for illustration purposes. We confirm that there is no error in the swamp details that have been used in the analysis resulting from the diagrams using standard map data.

JACOBS

Memorandum

Response to feedback provided on the Barwon Downs Vegetation Report 2016 by LAWROC

3. Vegetation Survey site co-ordinates

We have reviewed the data on vegetation transects that we have set up and monitored. We are confident that the data we are using is correct. In the field, the vegetation survey sites T1 to T14 are physically marked with a stake showing the start and end of each transect. Survey sites located in the State Park are not marked with a stake, as this was not permitted. These sites are re-located each time using the co-ordinates and photographic evidence.

The background to the selection of the vegetation survey transects is described below:

- Transects were initially selected after a site inspection in 2013 and the coordinates of the approximate centre of each proposed transect are provided in SKM (2013).
- In 2014, groundwater monitoring bores were installed as close as possible to the selected transect sites, to enable essential groundwater monitoring for each transect. In some cases, access restrictions and/or site conditions prevented the bores being installed exactly at the selected site coordinate, which means the bores are located as close as physically possible to the selected site coordinate (e.g. TB3, TB4, TB13 and TB14).
- Vegetation transects used and surveyed in 2014 and 2016 took into consideration the location of the bores and the ability for each transect to adequately monitor potential changes in vegetation (i.e. the transect needed to be at the edge of the groundwater dependent ecosystem). This resulted in four transects sites being at a slightly different, but nearby location from the initial location selected in 2013 (e.g. TB3, TB4, TB13 and TB14).

Vegetation transect site locations have not changed since they were selected in 2013. However four sites were located slightly different to the nominated central point to accommodate access issues, locations of monitoring bores and ensure transects are well positioned to capture potential changes (i.e. at the edge of the groundwater dependent ecosystem).

We have compared the co-ordinates published in Jacobs (2016), Jacobs (2015) and those provided in the SKM (2013).

Reporting mistakes in the co-ordinates were found in Jacobs (2015). Co-ordinates presented for some sites had been carried over between site maps (essentially these are typing errors) in Jacobs (2015), however the actual co-ordinates of the sites where the surveys were conducted were correct. Jacobs will provide an addendum to the report with the correct co-ordinates to remove any confusion about the site locations.

To illustrate this point, the co-ordinates from both reports are provided below. Text in red shows the sites where the co-ordinates have been entered incorrectly. Co-ordinates for two sites were not provided in the Jacobs (2016) report, but are not altered. This can be updated in the report if required.

Transect locations are shown with a T and associated observation bores are shown with a TB. For example, Transect One is shown as T1 and the associated observation bore is shown as TB1. With T1 the TB1 bores are 500 metres away and do not fit the description mention here and raise many more inaccuracies in this explanation***. Otway Water Book 31 deals with this in some detail***.

JACOBS

Memorandum

Response to feedback provided on the Barwon Downs Vegetation Report 2016 by LAWROC

Site	2015 Report				2016 Report			
	Start		End		Start		End	
	E	N	E	N	E	N	E	N
T1	735298	5743774	735248	5743822	735298	5743774	735248	5743822
T2	734632	5744000	734654	5744034	734632	5744000	734654	5744034
T3	*734632*	*5744000*	*734654*	*5744034*	732087	5743543	732097	5743503
T4	*734632*	*5744000*	*734654*	*5744034*	732901	5744483	732928	5744212
T5	730923	5744000	734654	5744034	730923	5743952	730899	5743970
T6	729402	5743247	734654	5744034				
T7	727517	5742297	727483	5742294	727517	5742297	727483	5742294
T8	734219	5741628	734181	5741631	734219	5741628	734181	5741631
T9	*734219*	*5741628*	*734181*	*5741631*	731875	5735445	731855	5735470
T10	*731219*	*5741628*	*734181*	*5741631*	728420	5739932	728436	5739895
T11	730431	5737070	728436	5739895	730431	5737070	730416	5737039
T12	*729592*	*5738949*	*729603*	*5738989*	731169	5740151	731169	5740189
T13	729592	5738494	729603	5738989	729592	5738949	729603	5748989
T14	726670	5740017	726644	5740039				

The co-ordinates presented in Jacobs (2016) show the **start and end of the transect** line projected in Zone 54. The co-ordinates in the licence and SKM (2013) show the proposed **centre point** of the transect and are projected in Zone 55.

The co-ordinates presented in SKM (2013) have been plotted on the same location maps provided in Jacobs (2016), projected in the same zone, to demonstrate that the location of the vegetation transects are consistent with the co-ordinates listed in SKM (2013).

Location maps for each site are provided at the end of this document.

4. Big Swamp location map

Jacobs assume that this statement refers to Figure 3-1 in the Jacobs (2016), which is also provided below. The map shows a line that describes Boundary Creek as running through the centre of an inundated area that approximates Big Swamp.

The spatial data set for the streams is a standard Vicmap dataset, published by the Victorian Government and the reference information is provided here: https://www.data.vic.gov.au/data/dataset/vicmap-hydro-watercourse-streams.

We recognise that the published map information for Big Swamp is a simplification of the situation on the ground. We have used the data for illustration purposes to help locate transects. This does not feed into the analysis. Thus there is no error in the assessment that is introduced by the use of the standard map data. It should be noted that site inspections of Big Swamp conducted over the years has noted the presence of a channel that runs along the northern boundary of Big Swamp.

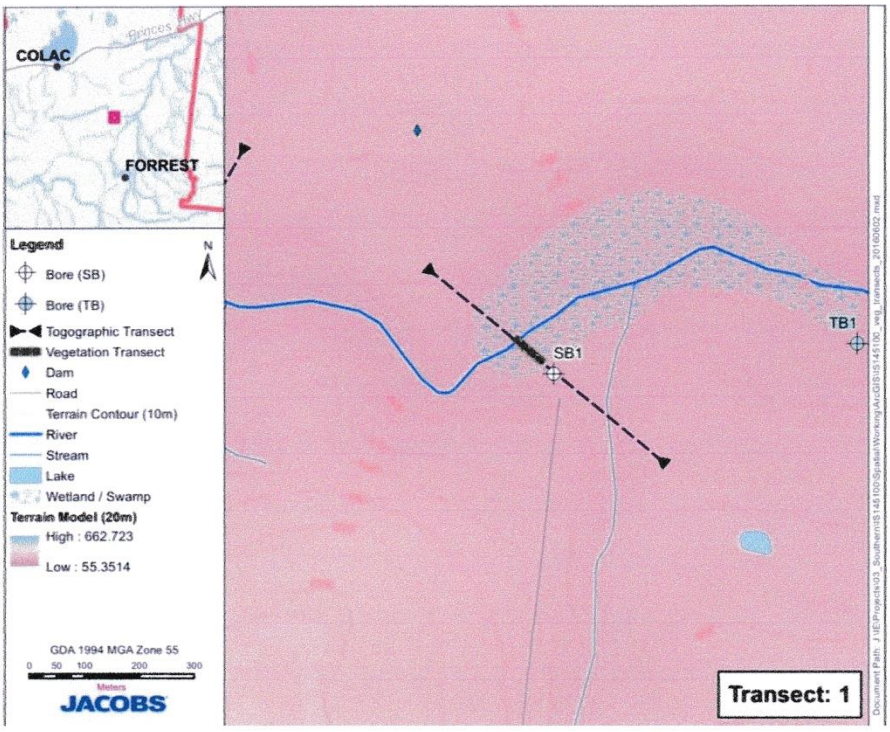
JACOBS

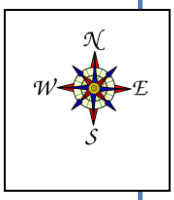
Memorandum

Response to feedback provided on the Barwon Downs Vegetation Report 2016 by LAWROC

Recent field work completed in April 2016 after heavy rain highlighted that flow in Boundary Creek enters the Swamp via a channel at the eastern end, and flow then spreads across the swamp flowing through a braided network of small channels before eventually discharging at the western end via a drainage line and the main creek line. The channel that runs along the northern boundary of the creek was dry in April 2016.

Jacobs will continue to monitor water movement through the swamp and the northern channel over the next few months to improve our understanding of surface water flow movement through the swamp.





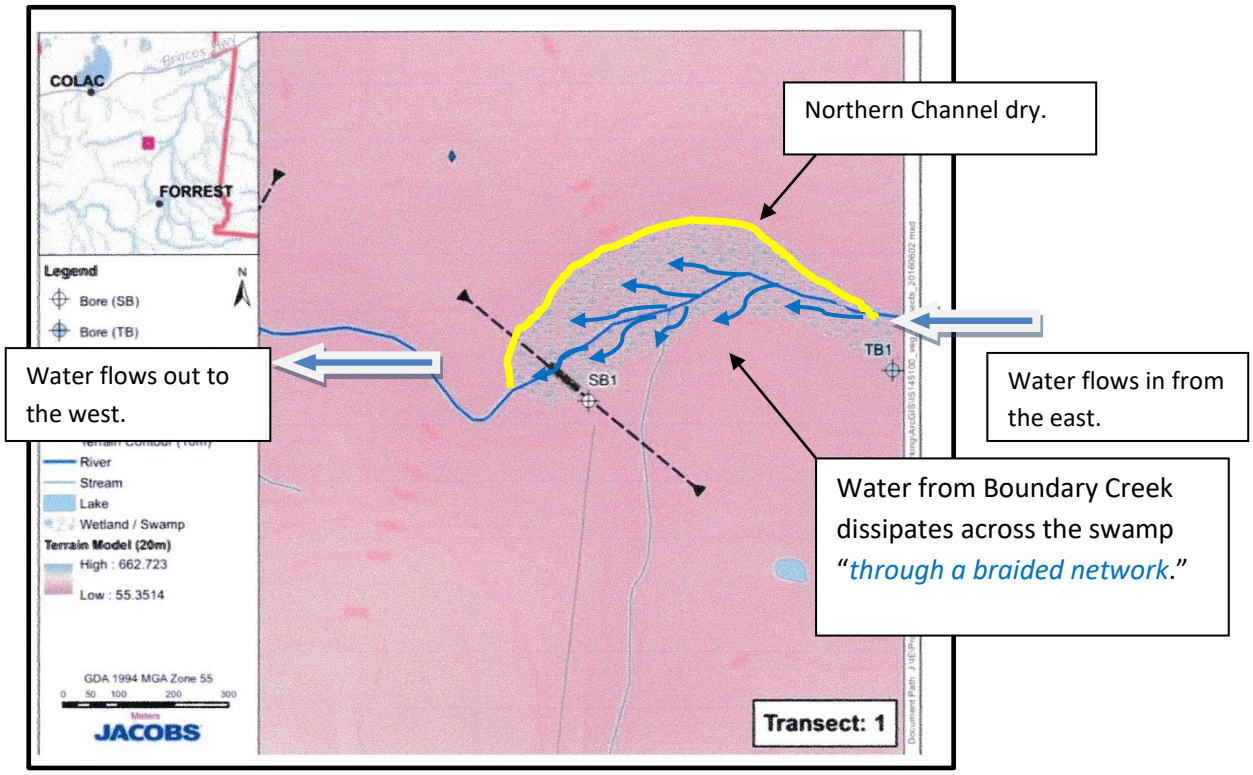
5. References

Jacobs (2015) Barwon Downs Vegetation Monitoring Report 2014/15. Unpublished report for Barwon Water prepared by Jacobs Australia

Jacobs (2016) Barwon Downs Vegetation Survey 2016. Final report 31 January 2016

SKM (2013) Barwon Downs Monitoring Program - STAGE 1 Field Investigations and Monitoring Program Scope', Unpublished report for Barwon Water prepared by SKM.

If the Jacobs' description of the April 2016 field work as described on page **47** was added to the map above, it would look something like this ...



Some comments regarding Jacobs' 5 June 2017 reply.

1. The 2015 vegetation report had been "ticked" off as complete and correct by 5 people before being sent to Southern Rural Water as a final document. The 2015 vegetation report was prepared and presented to Southern Rural Water as one of the groundwater extraction licence conditions. To make matters worse Southern Rural Water also passed this report as correct and acceptable.
2. When first told that the co-ordinates of the vegetation sites should be checked the answer was far from satisfactory and did not resolve the issue (see page**38**).
3. Then the latest response to the incorrect co-ordinates is also far from satisfactory and does not instil any confidence in the work Jacobs is conducting.

a) Being a report on which water resource management decisions are made, the contents should be accurate and reliable. Documentation needs to present a true representative of work conducted and observations made. Report 2015 does not do this.

b) Point three of the Jacobs' report states "***These sites are re-located each time using the co-ordinates and photographic evidence.***" If using the

grid references given in report 2015, relocating the sites would be impossible. Sites with the same grid references up to 5 kilometres apart could not be found easily, and considerable confusion and bewilderment would result.

c) Any follow up work, scrutiny and visitation would be rendered impossible.

d) Jacobs had moved vegetation sites, and or completely deleted sites used in earlier surveys, giving the reason that these sites had inaccurate grid references or could not be accessed. The 2015 report of Jacobs, if unquestioned would have perpetuated this problem.

e) Irrespective of the motivation for changing sites, the data, explanation and descriptions of sites must be proofed, accurate and reliable, especially when the documentation is claimed to have undergone rigorous scientific and technical procedures.

f) Documents produced by consultants such as Jacobs need to be seen as beyond reproach. Historically these documents become the bench mark and reference material used in future resource management decisions. They must be able to stand up to the strictest scrutiny.

g) Jacobs reply includes this statement."***Co-ordinates for two sites were not provided in the Jacobs (2016) report, but are not altered. This can be updated in the report if required.***" The 2016 report should have included this as a matter of course and not be left up to a Landcare Group to request that all data be included in a report.

Gross typographical errors, assumptions and omissions lead to confusion and incorrect conclusions. Rigorous scientific process should not function in this way, also,

4. whichever way ones twists or shakes the section answering the Big Swamp discrepancies, the explanation given is at best fractionally correct, and at worst, nowhere near the actual situation and observable data.

The original 2016 description of the Big Swamp site states... "***This site is located within the Big Swamp into which Boundary Creek flows and dissipates before reverting to a channel west of the Colac-Forrest Road.***"

To the casual reader, combined with the accompanying map (see page 47), this most definitely gives the impression that Boundary Creek does indeed flow through and across the Big Swamp for all of its course. This is most definitely not the case. This is an incorrect assessment. To make matters worse to then say in the latest explanation... "***Thus there is no error in the assessment that is introduced by the use of the standard map data.***" is also incorrect use of the illustration and description. This is not acceptable in a document purporting to follow rigorous scientific endeavour.

5. Further, "insult" upon "insult" is added in the reply to the incorrect use of the "... ***standard Vicmap dataset***..." when the following explanation is given in Jacobs' 5 June 2017 reply.

"***Recent field work completed in April 2016 after heavy rain highlighted that flow in Boundary Creek enters the Swamp via a channel at the eastern end, and flow then spreads across the swamp flowing through a braided network of small channel before eventually discharging at the western end via a drainage line and the main creek. The channel that runs along the northern boundary of the creek was dry in April 2016.***" (see pages 47-48)

For this to happen the water flow in Boundary Creek would have to be flowing uphill. Boundary Creek flows west to east not the other way round.

Secondly, Boundary Creek flows around the northern flank of the Big Swamp and will only overflow into the upper and middle sections of the Big Swamp since groundwater extraction, in excessively large rainfall events, and on very rare occasions. In the last 9 years I have never witnessed this happening.

Thirdly, during normal rainfall events and pre groundwater extraction the northern channel, which is in fact a meandering Boundary Creek, is never dry.

Under heavy rainfall events the lower end of the Big Swamp does have overflow from Boundary Creek dissipating across the swamp (see pages 51-52).

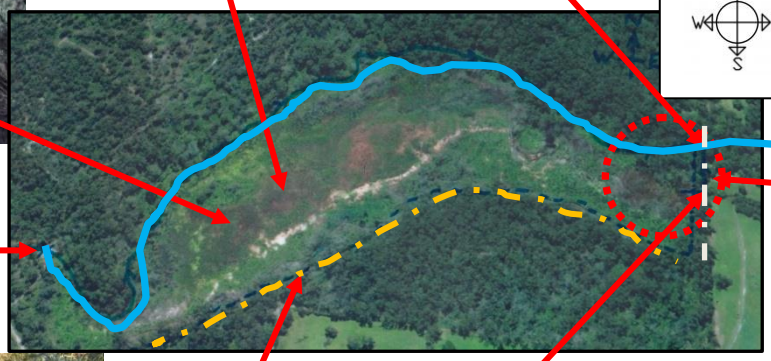
With so many mistakes and discrepancies that can be found in Jacobs' reports it is difficult to place any credibility on the thoroughness, precision, accuracy cross referencing and sound record keeping practices being practised by Barwon Water's consultant. The question then arises what other documentation is conducted in a similar fashion and then fed into a modelling program on which resource management decisions are made.

During a visit to the Big Swamp 4 July 2017 (see page 51) shows how the Boundary Creek flow enters the swamp area and turns sharply to the north, then hugs hard up against the steeply rising topography. The southern fire prevention trench was dry as is usual, for its entire length. The Big Swamp was also dry all the way down to the very lower end of the swamp near Stewart's boundary where it dissipated across this reach. The water was flowing into the eastern fire trench and then flowed into a man-made trench in the Stewart's property flowing south to north, before re-entering Boundary Creek (see page 52). Boundary Creek was flowing along the "northern channel" around the Big Swamp for its entire length. The eastern fire prevention trench has always had water in it since it was dug in 2010.

Photographs taken 12-07-2017

Top end of swamp at least 60cm above water level.

Flow out of swamp along B/Creek.



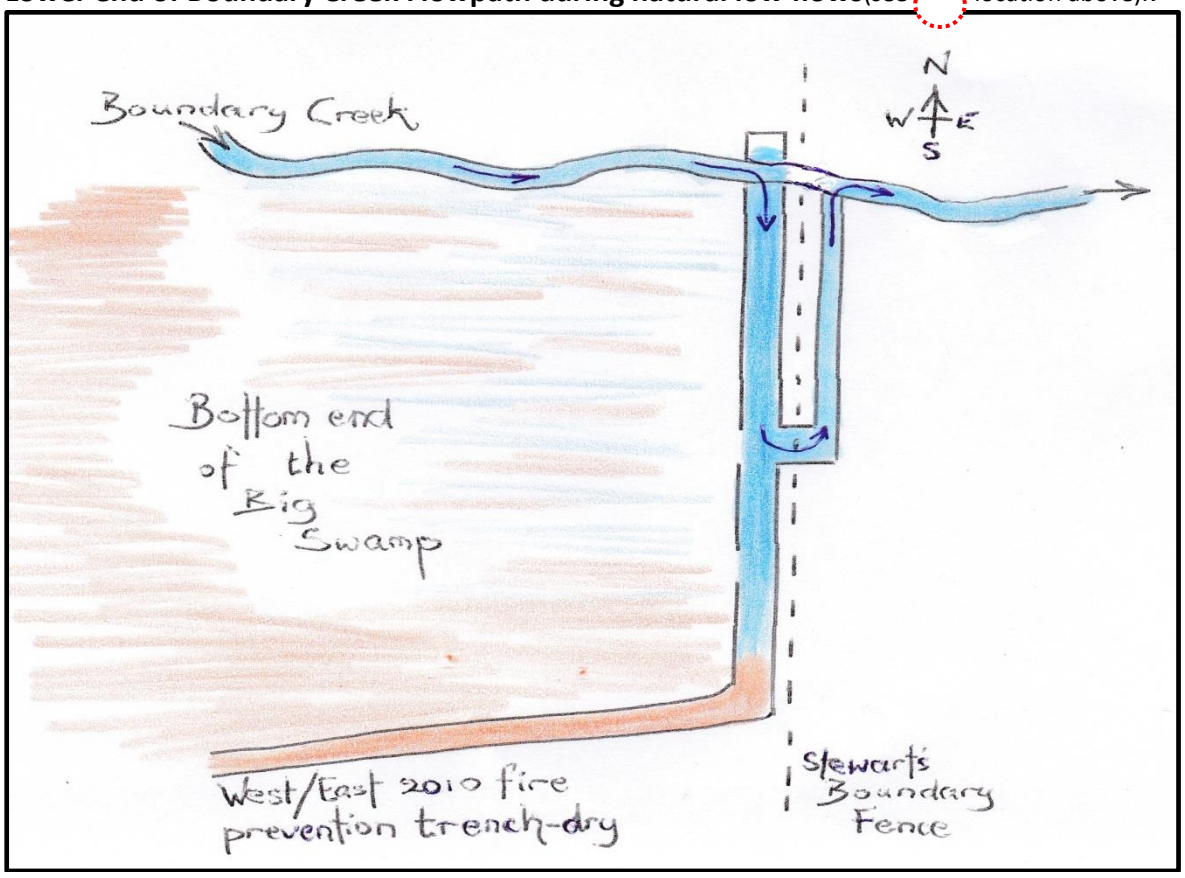
West to east flow at crossing above the Big Swamp.

Water flows out of south/north fire prevention trench and flows north back into B/Creek(see page 52).

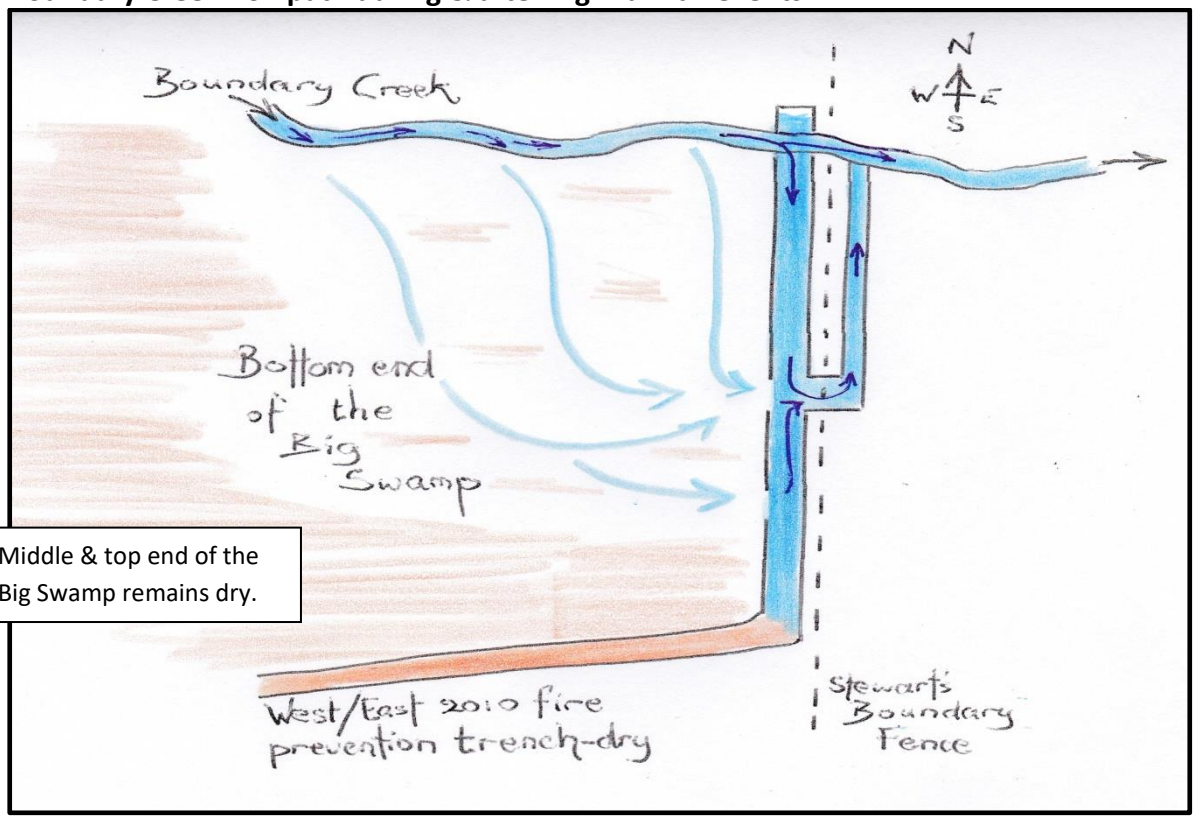
Lower end of swamp where water can dissipate across the swamp in high flow periods..

Southern trench dug in 2010 to prevent peat fire escaping. DRY - never flows with water.

Lower end of Boundary Creek Flowpath during natural low flows(see location above)..



Boundary Creek flowpath during & after high rainfall events.



Middle & top end of the Big Swamp remains dry.

Conceptual drawings.

Tricia (LAWROC President) was asked how LAWROC wished to proceed with sharing the rest of the LAWROC/Otway Water Book 31 report with Barwon Water(see the bottom of email page **43**). The following email explains LAWROC wishes.

From: Mal Gardiner [mailto:otwaywater@yahoo.com.au]
Sent: Tuesday, 18 July 2017 5:57 PM
To: Jo Lee <Joanna.Lee@barwonwater.vic.gov.au>
Subject: LAWROC REPLY

Hello Jo,

Just finished talking to Tricia our President, after a call from Peter Morgan. Peter wanted to know the source of my comment in the Colac Herald where I was talking about water flowing up hill. This relates to the 5 June 2017 Jacobs' letter you sent. I thought the LAWROC Group had replied to that particular email. After speaking to Tricia we realise this had not been done.

See Colac Herald article page **56**

As a result Tricia has asked me to send you the Group's response to the Jacobs' reply to the queries/mistakes found in their reports.

The Group decided the following...

Dear Jo,

Thanks for having Jacobs reply to queries/mistakes (LAWROC's email query dated 29 May 2017),that our Landcare Group found in recent reports (Jacobs reply dated 5 June 2017, Project No. IS191000). Unfortunately the Group does not agree with or hold the same amount of confidence in Jacobs's work as you do. For Barwon Water to "...have great confidence that the monitoring program is scientifically rigorous, and comprehensive..." seems to be misplaced when other significant mistakes have been made in Jacobs' reply.

Malcolm Gardiner.

Vice President LAWROC Landcare Group.

End LAWROC response.

Malcolm

On Wednesday, July 19, 2017, 09:51, Jo Lee <Joanna.Lee@barwonwater.vic.gov.au> wrote:

Hi Malcolm,

Thanks for getting back to me about the response from LAWROC. Appreciate the time the group has taken in reviewing the response from Jacobs.

I must admit too, that I didn't really understand what you meant about your comment in the Colac Herald about water flowing up hill. Would you have time to come in 15 minutes earlier before the Boundary Creek meeting on Friday to go through the Jacobs response with me? I would like to understand in more detail what the other significant mistakes Jacobs had made in their reply to the issues LAWROC had raised. It would be a really good outcome if we can clear this up and make sure the report is accurate.

See page 57 in Appendix 1 for some comment on this.

See you on Friday – please let me know if 2:45pm at the Barwon Water Colac office suits.

Thanks,

Jo

Joanna Lee
Senior Engineer, Water Resources Planning I Barwon Water
55 – 67 Ryrie Street I P.O. Box 659, Geelong, Victoria 3220
T (03) 5226 2471 I M 0407 647 168 I W www.barwonwater.vic.gov.au

I respectfully acknowledge the traditional custodians of the land where I work, and the Elders past, present and future.

Jo and Rhys did meet with me and fruitful discussion took place. Through the direction of new Managing Director of Barwon Water and the manner in which Jo and Rhys handle themselves as Barwon Water representatives, I have every confidence that these particular issues will be dealt with. However, the confirmation of this confidence will only come after written unambiguous follow-up.

- ✓ Correction of Timeline of local community involvement
- ✓ An explanation of how the 5 June Jacobs' reply to queries could be so inaccurate, misinformed and or blatantly wrong
- ✓ A correct description of how the water flows in Boundary Creek and the Big Swamp interact
- ✓ Explanation how 5 "experts" were able to miss so many basic mistakes in official documentation

✓ How Southern Rural Water scrutiny missed the same mistakes.

Barwon Water confirms impact of bore pumping

Barwon Water has confirmed that pumping groundwater from a Barwon Downs borefield has impacted the water flow to Boundary Creek.

The results come after water campaigner Malcolm Gardiner raised his concerns for more than 10 years about the effect that pumping the Barwon Downs borefield would have on the region's waterways.

Yeodene's Nellie Shalley has previously expressed her concerns to the *Colac Herald* about Boundary Creek, which flows through her property south-east of Colac, drying up in summer.

She said that she believed groundwater pumping at a borefield near her property had depleted the creek's flow.

A Barwon Water spokeswoman said the study was a comprehensive groundwater monitoring program that launched in 2013 to help inform Barwon Water's Barwon Downs borefiled renewal application, which the corporation is due to submit in late 2017.

Barwon Water general manager strategy and partnerships Carl Bicknell said the data was a result of a major update to the groundwater model for the Barwon Downs area.

The study found that use of the borefield over the past 30 years was responsible for two thirds of the reduction in base flow from the aquifer into Boundary Creek, while the dry climate during the same time accounted for the remaining third.

The spokeswoman said the model showed the lower sections of Boundary Creek "would likely have" no-flow periods during summer regardless of groundwater pumping, but pumping had increased the frequency and duration of no-flow periods in lower reaches of Boundary Creek.

The data confirmed there was no predicted impact to vegetation outside the Boundary Creek catchment as a result of groundwater pumping.

Mr Bicknell said it had been known for some time that borefield pumping was connected to flows in Boundary Creek, but the level of interaction had not been fully understood.

"As a condition of our current groundwater licence we have released supplementary flows into Boundary Creek," he said.

"However, we know these flows have not always made their way to the lower reaches of the waterway.

"We now have results of a thorough scientific study that provides answers we can be confident in, allowing us to examine ways to restore flows that will compensate for the operation of the borefield."

The spokeswoman said the borefield was a "crucial" supplementary water source for Geelong, the Surf Coast, Bellarine Peninsula and parts of Golden Plains Shire when surface storages were low.

She said that in 2007, at the height of the worst drought on record, the borefield provided up to 70 per cent of the Geelong's daily water supplies.

Mr Bicknell said further technical studies were underway to assess the effect of a range of alternative borefield operating regimes on flows in Boundary Creek and measures to address the issue of acid water release from Big Swamp into Boundary Creek.

The outcomes of these studies, as well as planned community engagement in the coming months, will provide information for Barwon Water's licence application.

PHOTO SUPPLIED

IMPACT: Nellie Shalley inspects a dry Boundary Creek in 2007.

Colac Herald, Wednesday, June 28, 2017

[file(6a)]

Colac Herald, FRIDAY Jan 18, 1991 Page 3

Board accepts blame for dry creek

by Mary Dracup

The Geelong District Water Board has admitted responsibility for the low level of Boundary Creek over the last two summers.

A spokesman for the board said on Tuesday that the creek's recent dryness had probably been caused by test groundwater pumping at Gerangamete between November 1988 and March 1990 and the board was monitoring the affect closely.

"The whole reason for the test pumping was to monitor the results. We have to monitor the recovery rate of the aquifer and try to get a long-term picture of the affects this kind of pumping has," the spokesman said.

He said it was still too early to say what the results of the pumping had been — it would not be until the end of 1992 that the board's investigations would be complete.

He said the board's test pumping was condoned by the Natural Resources and Environment Committee, which had recommended looking to groundwater for future water requirements after its inquiry in 1989.

Nevertheless, he said the board was conscious of problems such as Boundary Creek drying up in summer, and was trying to find ways to solve them.

"If this kind of affect was to happen because of pumping we would have to look at ways to get around it. It's not a question of going ahead at any cost."

Meanwhile, the spokesman said there would be no further test pumping until after the investigations were complete.

8 out of 17 paragraphs in this article are pure spin and or inaccurate.

A very accurate or prophetic heading for 1991, but at no stage then or now, has Barwon Water or any other Government Authority put it in writing that groundwater extraction has caused the creek to run dry or that the borefield has caused the Big Swamp to dry out.

6 | Colac Herald, Monday, July 10, 2017 www.colacherald.com.au

Call to stop pumping borefield

Kawarren resident Malcolm Gardiner says Barwon Water should cease pumping the Barwon Downs borefield until the aquifer replenishes.

Barwon Water last month released a statement which stated the impacts pumping the Barwon Downs borefield had on Boundary Creek.

The statement was a result of a monitoring program which Barwon Water launched in 2013 to help it apply to renew its licence to harvest the water.

The study stated that Boundary Creek would likely have no-flow periods in summer regardless of groundwater pumping, but pumping had increased the frequency and duration of these no-flow periods.

But Mr Gardiner, who is a member of the Barwon Downs community reference group, said he believed Boundary Creek's no-flow periods were due to the aquifer not having water to replenish the creek's flow.

Mr Gardiner, who has campaigned for the cessation of pumping of the borefield for 30 years, said he believed the studies, which would aid Barwon Water's application for a renewed licence to pump the borefield, were not technically correct.

"Having years of access to data regarding the issue, a different picture emerges," he said.

"I am most definitely not confident in the scientific studies and to say they are thorough is a gross overstatement."

Barwon Water general manager strategy and partnerships Carl Bicknell said "Barwon Water was undertaking a rigorous, scientifically-based monitoring program to enhance the understanding of the impacts of operation of the Barwon Downs borefield".

"The updated groundwater model developed for the borefield meets the highest ranking under the National Water Commission's Australian Groundwater Modelling Guidelines," he said.

Mr Gardiner said he believed pumping of the borefield had caused drying of wetlands, vegetation loss and caused actual acid sulphate soil contamination.

He said it had also caused "other water-dependent wetland sites drying out and causing change of vegetation to opportunistic dry-land vegetation".

"Boundary Creek to stop flowing outside rainfall periods, a massive fish kill down the Barwon River," he said.

Mr Gardiner said pumping of the borefield had also reduced flows in the Gellibrand River and Loves Creek catchments.

"To continue extraction is to continue to mine the water resource and that spells further disaster of monumental proportions," he said.

People can share their views about the Barwon Downs boerfield at www.yoursay.barwonwater.vic.gov.au/barwon-downs-borefield-licence-renewal

Mr Bicknell said Southern Rural Water would assess the data collected during the monitoring program when SRW considered Barwon Water's licence renewal application.

"It is expected that any new licence issued by Southern Rural Water will include conditions for operation of the borefield that will mitigate risk of future impacts," he said.

Colac Herald
12 July 2017

Water report flaws

In last Monday's *Colac Herald* Barwon Water's general manager strategy and partnerships, was quoted as saying "Barwon Water was undertaking a rigorous, scientifically based monitoring program to enhance the understanding of the impacts of operation of the Barwon Downs Borefield".

From this it is obvious that Barwon Water has confidence in the consultants, which is understandable considering the money committed to this program.

However, when the consultants conducting this scientifically based monitoring program are able to report that water in Boundary Creek is now flowing uphill something is terribly wrong. And, this is just one example of the many technical and scientific mistakes.

As for Southern Rural Water assessing and scrutinising the results of this "rigorous scientifically based monitoring", the same types of mistakes are given the stamp of approval.

I must add I have been impressed with Tracey Slatter's way forward, but what must also be said is, if Barwon Water conducts its public relations and consultation based on poorly conducted scientifically based outcomes, then the problems and outrage will continue.

Malcolm Gardiner,

Come back to CH July 19 2017

If Barwon Water conducts its public relations and consultation based on poorly conducted scientifically based outcomes, then the problems and outrage will continue.

Addendum – Appendix 3 (see page 62) contains a copy of the correspondence regarding a draft of Otway Water Book 39 that was sent to Barwon Water for its consideration. Book 39 scrutinises Jacob's "Boundary Creek Aquatic Ecology Investigation," dated 17 March 2017.

APPENDIX 1.

Throughout the review process of the New Monitoring Program leading up to the Barwon Downs Borefield licence renewal, numerous reports have been prepared amounting to an enormous amount of text. Unfortunately in this day and age there appears to be a reluctance by the "general Public" to closely scrutinise anything other than a summary of very limited length. Often a quick glance at the executive summary; a browse through the text and a read of the conclusion is seen as reviewing the report. And, as long as a report reads well and makes logical sense from the data presented then the report is "ticked" off as acceptable. However, to make informed decisions each of these reports needs to read thoroughly scrutinised and be pulled apart piece by piece, checking the validity of the content. Every effort to source background material must be done. This is not an easy task and takes considerable time and effort to achieve. A thorough working knowledge is essential if correct management decisions are to be the final outcome. Also it is a high order expectation to ask a Community Reference Group to perform this task. By the time a report is presented to community members for their consideration it should have undergone a comprehensive screening process.

Barwon Water should demand that its consultants conduct a thorough program of investigation and expect that reports presented to a Community Reference Group has undergone a rigorous scientific and technical screening process, but this does not appear to be the case.

If Barwon Water aligns itself with Jacob's mistakes by maintaining the stance of having confidence in Jacob's work, then Barwon Water's credibility will suffer.

APPENDIX 2

Executive Summary by Roger Blake.

1. Environmental damage in the Boundary Creek, "the Big Swamp" and the Barwon River

Pumping from the Gerangamete Borefield lowered the aquifer pressure and therefore the water table below the Boundary Creek and surrounding intake area. This diverted surface water from the Boundary Creek and "the Big Swamp" into the aquifer below. The Boundary Creek became a "losing stream" and remained so as long as the water table remained below the surface level of the creek.

The complete drying out and degradation of Boundary Creek (a tributary of the Barwon River) that included the subsequent catching fire of "the Big Swamp" in 1997 and again in the same summer of 1998 and again in 2010 was caused by over pumping from the Gerangamete Borefield.

Very high to extreme pH values in Boundary Creek, first observed in June, 1990 resulted from acidification caused by drying out of "the Big Swamp". Extreme acid water (pH values from 3.0 to 4.0 or 1000 to 10,000 times normal) flowed into the Barwon River culminating in a massive fish kill in the Barwon River in June/July 2016.

2. The oxidation of pyrite in a Peat Swamp

When a peat swamp commences to dry out, for whatever reason, the chemistry of the peat dramatically changes. Once the peat commences to dry out oxygen is introduced into the peat. The pyrite (fools gold) in the peat, previously stable, commences to oxidize according to the following reaction.

Iron Sulphide + Oxygen + Water = Iron Sulphate + Sulphuric Acid

Sulphuric acid is a strong acid and is the electrolyte used in common lead-acid car batteries. At pH values less than 5.0 the sulphuric acid in solution is a toxic component of water and lethal to fish and other aquatic species

3. The cause of the extreme acid events in Boundary Creek

It can be concluded without any doubt that the cause of the very high acid content of Boundary Creek was the high levels of pumping in the Gerangamete Borefield. The high pumping levels from the aquifer caused the water level in the aquifer to drop permanently below "the Big Swamp" thus causing the peat swamp to dry out.

It can be concluded that drought was not a cause because the first extreme pH values in Boundary Creek appeared in June 1990, 15 years before the "Millennial Drought" commenced in 2005.

Similarly it can also be concluded that fire was not the cause of the extreme pH levels in the Boundary Creek. The peat in "the Big Swamp" caught fire in the very top

section of the Big Swamp in 1997 over seven years after the first extreme pH's were observed in June 1990. The lower reaches of the swamp caught fire in later years as the pumping from the Borefield progressed and the swamp further dried out.

4. Estimate of the long-term average recharge to the aquifer

In 1996 the DNRE published a report on the Barwon Downs aquifer and the Gerangamete Borefield. This is the current definitive published report of the aquifer and Borefield. The sustainable e DNRE estimated the total annual recharge on the Barongarook High by inputting a value of 20 sq. km for the area, an average annual rainfall of 900 mm and 8.0 percent of rainfall being infiltrated as recharge giving an annual recharge of 1,440 ML. The DNRE report rounded this value up to 1,500 ML per year.

This estimate of 1,500 ML per year of recharge is currently the most definitive published estimate of the recharge to the Early Tertiary aquifer on the Barongarook High area that is publically available. This is the sustainable yield from the aquifer and any more results in "mining" of the groundwater resource.

5. The Southern Rural Water (SRW) revised Borefield Licence

The current Borefield Licence issued by SRW in 2004 to Barwon Water is for 20,000 ML per year (or 80,000 ML in 10 years or 400,000 ML in 100 years).

The Licence includes a natural recharge component of 1,500 ML per year. This is the sustainable extraction calculated by the DNRE that can be achieved without "stressing" the intake area

The DNRE report included a "stressed component" of recharge. The "stressed component" from the aquifer is estimated by the DNRE to be 2,500 ML per year (i.e. the difference between their recommended 4,000 ML per year and the sustainable recharge of 1,500 ML per year). This additional component of groundwater can be extracted from the aquifer by over-pumping of the Borefield, as concluded by the DNRE. *"This enhanced recharge is largely derived from increased surface water infiltration and interception of groundwater inflows to Boundary Creek and spring systems on the Barongarook High"*. And further *"will result in the watertable being lowered on the Barongarook High and will have an impact on the Boundary Creek and associated spring systems because of the high degree of hydraulic connection that exists between the aquifer system in the graben and aquifer outcrop on the Barongarook High"*.

The current SRW licence effectively made a decision to licence not just the further "stressed component" of 2,500 ML per year (calculated above) to the Barwon Water Borefield but a total "stressed component" of 6,500 ML per year. This additional 6,500 ML per year is the difference between the sustainable component of 1,500 ML per year estimated by the DNRE and the effective 8,000 ML per year of the current licence. This 6,500 ML per year is taken from the surface water runoff from the

Barongarook High, which normally flows to the Barwon River via the Boundary Creek.

This decision by SRW to allocate the extra 6,500 ML per year was made in the full knowledge of the environmental effects detailed in the DNRE, 1996 report.

This licence to Barwon Water effectively excluded any landowners or communities in the Barwon River catchment from accessing the Early Tertiary aquifer on their properties because it allocated the full sustainable recharge rate to Barwon Water. This negated the groundwater entitlements of Barwon River catchment landowners

The SRW Borefield Licence effectively put the interests of the Geelong clients of Barwon Water ahead of the interests and water entitlements of Barwon River catchment landowners.

The current Borefield licence is effectively 8,000 ML per year over 10 years (or 20,000 ML per year in any one year). There is absolutely no difference between issuing a Licence for the Borefield of 1,500 ML per year and issuing a surface water licence to extract 6,500 ML per year from the Barongarook High and Boundary Creek. SRW could have achieved the same result of 8,000 ML per year by issuing a licence to pump 1,500 ML per year from the Borefield and by issuing a licence to put a dam across the Boundary Creek above the confluence with the Barwon River. A volume of 6,500 ML per year of surface water in the dam could have been piped (or pumped) from the dam to the Upper Barwon – Wurdee Bolac channel

If SRW had made a decision to dam the Boundary Creek and divert 6,500 ML per year to Barwon Water there would have been a requirement for a full Environmental Impact Statement (EIS). This would have required input from other Government agencies regarding its impacts and allowed for general public input, including affected landowners in the Barwon River catchment, into the decision. The SRW Licence therefore effectively removed the scrutiny required for further surface water allocations to Barwon Water.

By allowing the additional 6,500 ML per year to the Gerangamete Borefield Licence, SRW effectively removed a long-term sustainable flow of 6,500 ML per year of the Boundary Creek into the Barwon River.

The SRW decision to licence the additional 6,500 ML per year effectively bypassed the need for any Government Department, CCMA or public review of the sustainable surface flows contributed by the Boundary Creek to the Barwon River.

Over the 27-year period from 1983 to 2010 the total volume extracted of 122,358 ML was 3.03 times the total sustainable recharge of 40,500 ML (i.e. 27 times 1,500 ML) over the Barongarook High intake area over the 27-year period. It can be concluded that it is of no surprise that the Boundary Creek and Barwon River have responded in the way they have to this massive over exploitation of the groundwater resource. The aquifer is not being developed in a sustainable manner but is being "mined".

The groundwater consultants to Barwon Water (SKM now Jacobs) have long maintained that the sustainable yield from the Barwon Downs Borefield is vastly

greater than the DNRE estimate (up to 20,000 ML per year compared to 1,500 Ml per year estimated by the DNRE report, or by a factor of over seven times) but Barwon Water have never made available the basis on which their the consultants calculations are based.

There should be an independent technical audit of the consultant's estimates undertaken in order to determine the reason for the extraordinary discrepancy between the consultant's estimates of sustainable yield compared to those of the DNRE.

The commissioning of the independent audit should be by the relevant authorities, principally SRW with input from the CCMA, the authorities responsible for the determination of the Borefield licence and for the maintenance of environmental flows in the Barwon River, with input from the Barwon Catchment stakeholders.

6. Conclusions and Recommendations

A final conclusion is that the environmental degradation of the Boundary Creek and Barwon River is now obvious and action must be taken. It is not necessary to apportion blame for the current situation prior to undertaking action.

It is not appropriate to delay a decision by appointing new committees or undertaking further environmental studies, or technical audits which would have the direct effect of delaying addressing the problem and pushing remedial action into the "too hard basket".

A program of remedial works should be undertaken on Boundary Creek to address the presence of the very high to extreme acid waters. Environmental flows should be restored to the Barwon River, particularly in the vulnerable summer and autumn periods.

The Borefield licence expires in 2019 and should be revised downwards to the long term 1,500 ML per year, which is the sustainable volume of intake on the Barongarook High intake area, calculated by the definitive DNRE, 1996 report.

APPENDIX 3

Nov 2, 2017 @ 12:42. from email otwaywater@yahoo.com.au

Hello Jo,
A worthwhile meeting last night reported by all at our follow up meeting.

Below is another task adding to your workload, but this probably needs to go to Jacobs for their response, as they are the experts being paid to do a satisfactory job. You may also wish to pass this on to the CRG members.

The Group thought that to continue to promote BW's move towards change, the crit on SKM/Jacobs Aquatic report of Boundary Creek should be provided to BW for its consideration. This report is still in DRAFT form with several things still to be completed. If Jacobs do respond to this, LAWROC would appreciate any feedback.

LAWROC would also like to see the revised report of the 2015 Vegetation study where the co-ordinates have been corrected and the description of Transect 1 also corrected. The revised description of the Transect needs to include an accurate description of the Boundary Creek flows around the Big Swamp.

Kind regards,
Malcolm.

Malcolm Gardiner
1805 Colac Lavers Hill Road
Kawarren
Vic 3249
ph (03) 52 358 325
www.otwaywater.com.au

OTWAY WATER BOOK 39.pdf

Reply 19-12-2017 to otwaywater email.

Aquatic ecology report

Survey method

The intent of the aquatic ecology study was to gain a high level understanding of the species and communities supported by Boundary Creek. The approach taken was to balance the information already gathered from the area (i.e. targeted fish surveys, observational reports, database records) and to augment that information with a macroinvertebrate survey and site inspections. Targeted fish surveys were not undertaken.

One of the major issues with targeted field surveys is that absence cannot be definitively proven. And therefore, for example if we had relied heavily on an electrofishing survey conducted over a short period to inform our assessment of the species that could be supported by the creek, we would be rightly criticised.

In that context, it was our intent to consider more broadly the species that could be supported by the creek if there was flow of suitable quality and quantity, and in this way, inform the next phase of this study (i.e. the determination of low flow recommendations). Our approach resulted in a likely conservative estimate of the species supported by the creek. We believe this approach is appropriate because regardless of the results of a targeted survey, we would still have had to consider the species previously recorded as part of targeted surveys and observed from the creek and those that may occur as they are known from the area and have suitable habitat in Boundary Creek.

It should be noted that as a result of feedback from the CRG that additional Platypus investigations, including eDNA surveys, were completed. The results of this assessment, undertaken by independent scientist Josh Griffiths from Cesar consulting, is attached.

-

Additional fish studies and information

We were not previously aware of the fish surveys undertaken by the Arthur Rylah Institute referred to in the draft report (Otway Water Book 39). These results of these surveys will make an important addition to our understanding of the aquatic species and communities supported by Boundary Creek. We are currently attempting to source these reports and once we have obtained them, we will review and include all pertinent information in an addendum to the aquatic ecology report which will be completed in the first quarter of next year.

This addendum will also provide an opportunity to include additional relevant information raised in Otway Water Book 39 and to update our assessment. For example, the confirmation that a hole dug to support fire-fighting efforts provide suitable habitat for Southern Pygmy Perch (Nannoperca australis), as evidenced by the photos from 2016 on page 18 of the Otway Water Book, will allow us to refine our understanding of the biotic assemblage of the creek. In the report as it stands, Southern Pygmy Perch are assessed as being of low probability of being supported by Reach 2, but this will be amended.

-

Apology for the offence caused by the blunt use of language in the report

We acknowledge and apologise that an interpretation of our report was that we did not value the input of locally based stakeholders regarding their observations of the creek. This was not our intent. Following the public request for information in 2014, we were approached by Stewart Alford, John Day and Nellie Shalley who provided information regarding their knowledge of the creek and its biota. We attempted in our report to delineate the different information sources (i.e. targeted surveys, government database records, observations) but acknowledge that the language chosen to do so did not accurately portray the value of these contributions or their importance in assisting us to develop an understanding of the creek. We will be mindful of this in the future and appreciate the feedback.

As at February 2018 no Addendum provided.